User Manual

Allen-Bradley

MP-Series Integrated Multi-axis Linear Stages

Catalog Numbers MPMA-xABxxxx-S1C, MPMA-xACxxxx-S1C, MPMA-xAPxxxx-S1C, MPMA-xCBxxxx-S1C, MPMA-xCQxxxx-S1C, MPMA-xBExxxx-S2C, MPMA-xBIxxxx-S2C, MPMA-xBDxxxx-S2C

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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Notes:

Read this preface to familiarize yourself with the rest of the manual.

About This Publication

This manual provides detailed installation instructions for mounting, wiring, maintaining, and troubleshooting your MP-Series™ multi-axis integrated linear stage. For ease of use, going forward, when referring to the entire assembly, it may be called a multi-axis stage. Each axis of a multi-axis stage is a MP-Series integrated linear stage. When referring to single axis it will be called a linear stage.

Who Should Use This Manual

This manual is intended for engineers or technicians directly involved in the installation, wiring, and maintenance of multi-axis stages. Any person that teaches, operates, maintains, or repairs these multi-axis stages must be trained and demonstrate the competence to safely perform the assigned task.

If you do not have a basic understanding of multi-axis stages, contact your local Allen-Bradley/Rockwell Automation sales representative for information on available training courses before using this product.

Read this entire manual before you attempt to install a multi-axis stage into your machine. Doing so will familiarize you with the multi-axis stage components and their relationship to each other and the system.

After installation, check all system parameters to be sure you have configured your Logix control system properly.

Be sure to follow all instructions carefully and pay special attention to safety concerns.

Additional Resources

The following documents contain additional information concerning related Allen-Bradley products:

Resource	Description
Kinetix Motion Control Selection Guide, publication GMC-SG001	Information about Kinetix products
Kinetix 2000 Multi-axis Servo Drive User Manual, publication 2093-UM001	How to install, setup, and troubleshoot a Kinetix 2000 drive
Kinetix 6000 Multi-axis Servo Drive User Manual, publication 2094-UM001	How to install, setup, and troubleshoot a Kinetix 6000 drive
ControlLogix Multi-Vendor Interface Module Programming Reference, publication 1756-RM04	More detailed information on the use of ControlLogix motion features and application examples
ControlLogix SERCOS interface Module Installation Instructions, publication 1756-IN572	3, 8, or 16-Axis SERCOS interface module installation instructions
Logix 5000 Controllers Motion Instructions Reference Manual, publication 1756-RM007	The instructions needed to program a motion application
ControlLogix System User Manual, publication 1756-UM001	Information on configuring and troubleshooting your ControlLogix system
Logix5000 Motion Modules User Manual, publication LOGIX-UM002	Information on configuring and troubleshooting ControlLogix motion modules

Resource	Description
CompactLogix SERCOS Interface Module Installation Instructions, publication 1768-IN005	Information on configuring and troubleshooting a CompactLogix motion module
16-Axis PCI SERCOS Interface Card Installation Instructions, publication 1784-IN041	SoftLogix SERCOS interface PCI card installation instructions
SoftLogix Motion Card Setup and Configuration Manual, publication 1784-UM003	Information on configuring and troubleshooting your SoftLogix PCI card
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Information, examples, and techniques designed to minimize system failures caused by electrical noise
Kinetix Safe-off Feature Safety Reference Manual, publication GMC-RM002	Information, examples, and techniques to utilize safety-related features of Kinetix drives
Motion Analyzer, version 4.4 or later, is available at http://www.ab.com/motion/software/analyzer.html	Drive and motor sizing with application analysis software
Safety Guidelines for the Application, Installation, and Maintenance of Solid State Controls, publication SGI-IN001	Characteristics, application, installation, and maintenance of solid state controls
Rockwell Automation Product Certification Website, publication available at http://www.ab.com	For declarations of conformity (DoC) currently available from Rockwell Automation
National Electrical Code. Published by the National Fire Protection Association of Boston, MA.	An article on wire sizes and types for grounding electrical equipment
Allen-Bradley Industrial Automation Glossary, publication AG-7.1	A glossary of industrial automation terms and abbreviations
Kinetix Accelerator Toolkit Brochure, publication MOTION-BR004	Information about the Kinetix Accelerator Toolkit
Kinetix Accelerator Toolkit Quick Start, publication IASIMP-QS002	
Ultra3000 Digital Servo Drives Installation Manual, publication 2098-IN003	How to install, setup, and troubleshoot an Ultra 3000 drive
Ultra3000 Digital Servo Drives Integration Manual, publication 2098-IN005	
Home to Torque-level Example Application Notes, publication MOTION-AT001	Describes RSLogix 5000 homing routines
Kinetix 2000 Multi-axis Servo Drive Release Notes, publication 2093-RN001	Enhancements, known anomalies, and restrictions for your Kinetix 2000 drive firmware used with RSLogix 5000 software, version 16
Kinetix 6000 Multi-axis Servo Drive Release Notes, publication 2094-RN007	Enhancements, known anomalies, and restrictions for your Kinetix 6000 drive firmware used with RSLogix 5000 software, version 16
Motion Modules in Logix5000 Control Systems User Manual, publication LOGIX-UM002	Information on configuring and troubleshooting your ControlLogix and CompactLogix SERCOS interface modules, and using the home to torque-level sequence

You can view or download publications at http://literature.rockwellautomation.com. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Multi-axis Stage Safety

Introduction

This chapter describes the safety issues encountered while using multi-axis stages and the precautions you can take to minimize risk. Potential hazards discussed here are identified by labels affixed to the device.

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General Safety	12
Heat	12
Vertical or Inclined Payload	12
End of Travel Impacts	12
Air Freight Restrictions	12
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IMPORTANT Any person that teaches, operates, maintains, or repairs these multi-axis stages must be trained and demonstrate the competence to safely perform the assigned task.

Safety Labels

To prevent injury and damage to the linear stage, review the safety labels and the details and location for each table before using the linear stage. The stages are shown individually and un-stacked for clarity.

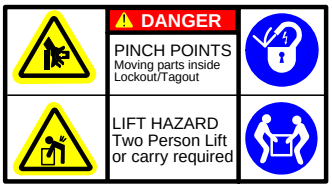
Title	Location	Label	Details
Danger - Pinch Points and Heavy Object	A		The multi-axis stages presents a muscle strain hazard if one person attempts to lift it. When attempting to move the linear stage use a three-person-lift to prevent personal injury or damage to the multi-axis stages. To Installer - There exists a Crush and Cut hazard while installing the multi-axis stages. The multi-axis stages weigh approx. 36.1 …90.3 kg (79.4…198.6 lb). To User - The Pinch Point label identifies a moving object hazard, caused by the movement of the carriage on the multi-axis stages Never put fingers, hands, or limbs near the multi-axis stages while running motion commands. Before executing any motion command, check that all maintenance tools have been removed from multi-axis stages. All types of multi-axis stages, present a pinch point hazard. This hazard may occur if fingers or hands come between the end cap and a moving carriage. Always install shipping clamps when attempting to lift multi-axis stages. Lift the multi-axis stages from the base of the lower axis and keep you fingers away from the strip seals.
Danger - Hazardous Voltage	B		The Hazardous Voltage label identifies the junction box as a hazardous voltage area of the multi-axis stages. To avoid injury be sure to follow Lockout-Tagout procedures before attempting maintenance on these multi-axis stages.
Danger - Strong Magnets	C		The Strong Magnets label identifies non-ionizing radiation found in the multi-axis stages. Magnet channels inside the multi-axis stages are constructed with strong magnets. Strong magnets can disrupt the functionality of automatic implantable cardioverter defibrillators (AICD); people with a pacemaker should not work near the linear stage. Maintenance personnel working on the multi-axis stages should avoid the use of metallic tools and secure items such as badge clip and other personal effects that could be attracted by the strong magnets. Strong magnets can erase magnetic media. Never let credit cards or floppy disks contact or come near the multi-axis stages.
Do Not Lift by Junction Box	D		Do not attempt to move the multi-axis stages by grasping the cable junction box. Moving the multi-axis stages in this manner will damage the multi-axis stages and create a pinch or crush hazard. The junction box is attached to the carriage, which is free to move. Lifting the multi-axis stages in this manner will allow uncontrolled movement of the heavy base. Always install shipping clamps, use a three-person lift, and grasp the multi-axis stages by the base of the lower stage at the end caps.
Stay Clear	E		Do not put hands or objects on the linear stage covers. Doing so could deform the cover and damage the linear stage, causing excessive wear on the cover supports or scraping noises when the linear stage is in motion.
Sharp Edges	F		Always remove strip seals before removing the top or side covers. If it becomes necessary to remove the top or side covers or change the strip seal, exercise care when working near or on the strip seal. The edges of the strip seal are sharp and can cut if accidentally hit or if handled inappropriately.

Figure 1 - Label Locations for Direct Drive Linear Stages

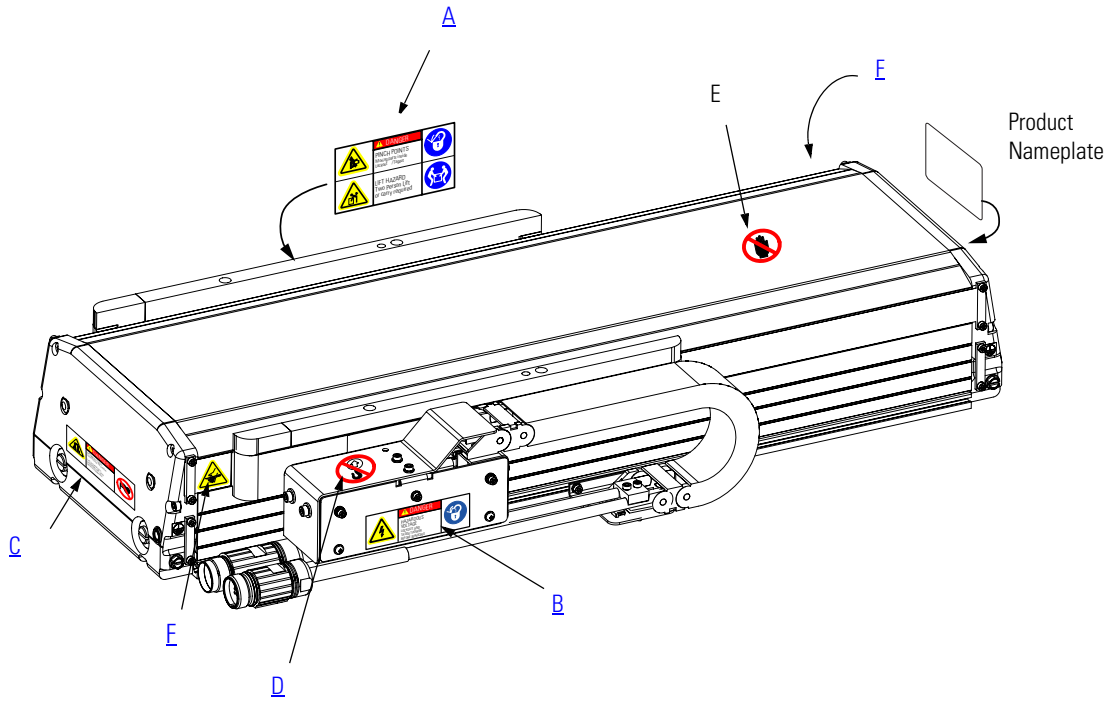
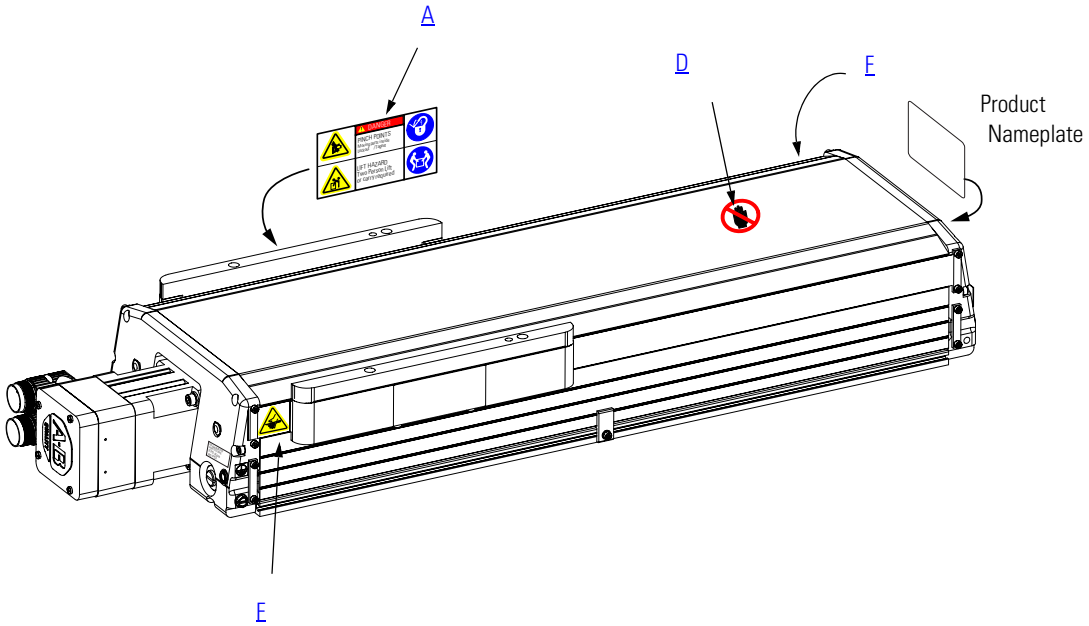


Figure 2 - Label Locations for Ball Screw Linear Stages



Clearances

Install the multi-axis stage to avoid interference with the building, structures, utilities, other machines and equipment that may create a trapping hazard of pinch points.

Dress cables using the Clearance Requirements on page 29 as a guide. Do not cross the path of motion or interfere with the cable carrier motion.

General Safety

Linear stages are capable of sudden and fast motion. Rockwell Automation, Inc. is not responsible for misuse, or improper implementation of this equipment.

Heat

When the stages are running at their maximum rating, the temperature of the carriage can reach 75 ºC (167 ºF).

Vertical or Inclined Payload

A direct drive (linear motor driven) linear stage mounted vertically or on an incline will not maintain position when the power is removed. Under the influence of gravity the carriage and its payload will fall to the low end of travel. Design engineers should allow for this by using a ball screw driven linear stage with power-off holding brake, or designing in controlled power down circuits or mechanical controls to prevent the linear stage and its payload from being damaged when the power fails.

End of Travel Impacts

The internal bumpers of the linear stages are designed to take a large impact from uncontrolled motion. The table on page 60 lists the energy that the bumpers can absorb before risking damage to the linear stage. The carriage payload should be secured to the carriage such that it will not sheer off in the event of an impact in excess of the bumper ratings.

The bolts securing the end caps will not be able to sustain multiple impacts and may eventually sheer. Correct the cause of the uncontrolled motion that caused the impact before continuing the use of the linear stage.

Air Freight Restrictions

When air freighting multi-axis stages, special preparations and precautions must be taken. The following information outlines the basic requirements at the publication date of this document. However, regulations are subject to change and additional area or carrier restrictions may be imposed. Always check with your carrier or logistics specialist regarding current local, regional, and national transportation requirements when shipping this product.

The 200 mm or a 250 mm direct drive linear stages (catalog numbers MPAS-A8*xxx*E-ALM*x*2*x*, MPAS-B8*xxx*F-ALM*x*2*x*, MPAS-A9*xxx*K-ALM*x*2*x*, or MPAS-B9*xxx*L-ALM*x*2*x*,) contain magnetized material, as classified by

International Air Transport Association (IATA) Dangerous Goods Regulations. An IATA trained individual must be involved when shipping this product via domestic or international air freight. Packing Instruction 902 provides information regarding the preparation of this product for air transportation. Follow these regulations for general marking and labeling requirements, the application of specific Magnetized Material Handling Labels, and instructions for preparing the Shipper's Declaration for Dangerous Goods.

As a minimum, refer to the following IATA Dangerous Goods Regulations:

- Subsection 1.5: Training
- Subsection 3.9.2.2: Classification as Magnetized Material
- Subsection 4.2: Identification as UN 2807, Magnetized Material, Class 9, Packing Instruction 902
- Subsection 7.1.5: Marking
- Subsection 7.2: Labeling
- Subsection 7.4.1: Magnetized Material Label
- Section 8: Shipper's Declaration for Dangerous Goods

When shipped via ground in the United States, these products are **not** considered a U.S. D.O.T. Hazardous Material and standard shipping procedures apply.

Standards

Standards and requirements applicable to this product include, but are not limited to, the following:

- ANSI/RIA R15.06, Industrial Robots and Robot Systems Safety Requirements - Teaching Multiple Robots
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery
- CSA/CAN Z434, Industrial Robots and Robot Systems- General Safety Requirements
- EN60204-1, Safety of Machinery. Electrical Equipment of Machines
- UL 1740, UL Standard for Safety Industrial Robots and Robotic Equipment

Motor Model Identification

The nameplate on ball screw driven linear stages lists the specific MP-Series servo motor model used.

Notes:

Understanding Your Multi-axis Stage

Introduction

Use this chapter to become familiar with the multi-axis stage components, its maintenance needs, and its configuration.

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Identifying Your Multi-axis Stage	16
Identifying the Components of Your Multi-axis Stage	17
Identifying the Individual Linear Stages in Your Multi-axis Stage	20
Identifying the Components of Each Linear Stage	20
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Bulletin MPMA multi-axis stages are comprised of custom Bulletin MPAS stages. The MPAS are custom due to the different cable management requirements for stacked-stage assemblies. Additionally, the Bulletin MPAS individual stage identifier embedded in the Bulletin MPMA catalog number does not correspond directly to the Bulletin MPAS catalog number used in the system combinations.

Identifying Your Multi-axis Stage

Your multi-axis stage is constructed using linear stages and a cable carrier module assembly. Use the following key to identify your multi-axis stage and its options. For details on an individual stages refer to Identifying the Individual Linear Stages in Your Multi-axis Stage.

MPMA - *xxxxxxxxx* - *xxx*

Cable Termination(1)

C = Cable track module with IP67 circular DIN-style connectors (applies to all Bulletin MPMA stages)

Limits and Brake Options

x-axis	y-axis	z-axis
1 = no brake, no limits	1 = no brake, no limits	1 = none
2 = no brake, no limits	2 = none	2 = 24V brake, no limits (ball screw only)

Protection Options (Same as Bulletin MPAS Options)(1)

S= Covered with strip seals

Z axis 10s of mm

0 = 0 mm	2 = 20	4 = 40 mm	6 = 60 mm	8 = 80 mm
1 = 10 mm	3 = 30	5 = 50 mm	7 = 70 mm	9 = 90 mm

Z axis 100s of mm

A = 0 mm	C = 200 mm	E = 400 mm
B = 100 mm	D = 300 mm	F = 500 mm

Y axis 10s of mm

0 = 0 mm	2 = 20 mm	4 = 40 mm	6 = 60 mm	8 = 80 mm
1 = 10 mm	3 = 30 mm	5 = 50 mm	7 = 70 mm	9 = 90 mm

Y axis 100s of mm

A = 0 mm	C = 200 mm	E = 400 mm	G = 600 mm
B = 100 mm	D = 300 mm	F = 500 mm	

X axis 10s of mm

0 = 0 mm	2 = 20 mm	4 = 40 mm	6 = 60 mm	8 = 80 mm
1 = 10 mm	3 = 30 mm	5 = 50 mm	7 = 70 mm	9 = 90 mm

X axis 100s of mm

A = 0 mm	C = 200 mm	E = 400 mm	G = 600 mm	I = 800 mm
B = 100 mm	D = 300 mm	F = 500 mm	H = 700 mm	J = 900 mm

Bulletin MPAS Linear Stage

x-axis (base)	y-axis (secondary)	z-axis (secondary)
B = MPAS-*x9xxx*K/L-ALMSX	B = MPAS-*x8xxx*F/E-ALMS2X	B = none
C = MPAS-*x9xxx*K/L-ALMSX	C = MPAS-*x9xxx*K/L-ALMS2X	C = none
D = MPAS-*x9xxx*K/L-ALMS2X	D = none	D = MPAS-*x6xxx2*-V20S4X
E = MPAS-*x8xxx*F/E-ALMS2X	E = none	E = MPAS-*x6xxx2*-V20S4X
I = MPAS-*x8xxx2*-V20S2X	I = none	I = MPAS-*x6xxx2*-V20S4X
P = MPAS-*x8xxx2*-V20S2X	P = MPAS-*x8xxx2*-V20S2X	P = None
Q = MPAS-*x9xxx2*-V20S2X	Q = MPAS-*x8xxx2*-V20S2X	Q = None

Configuration

A = Center Stacked XY
B = Center Stacked XZ
C = Cantilever Stacked XY (Left Side Cantilever)

Voltage(1)

A = 230V Motors
B = 460V Motors

Series Type

MA = Multi-axis

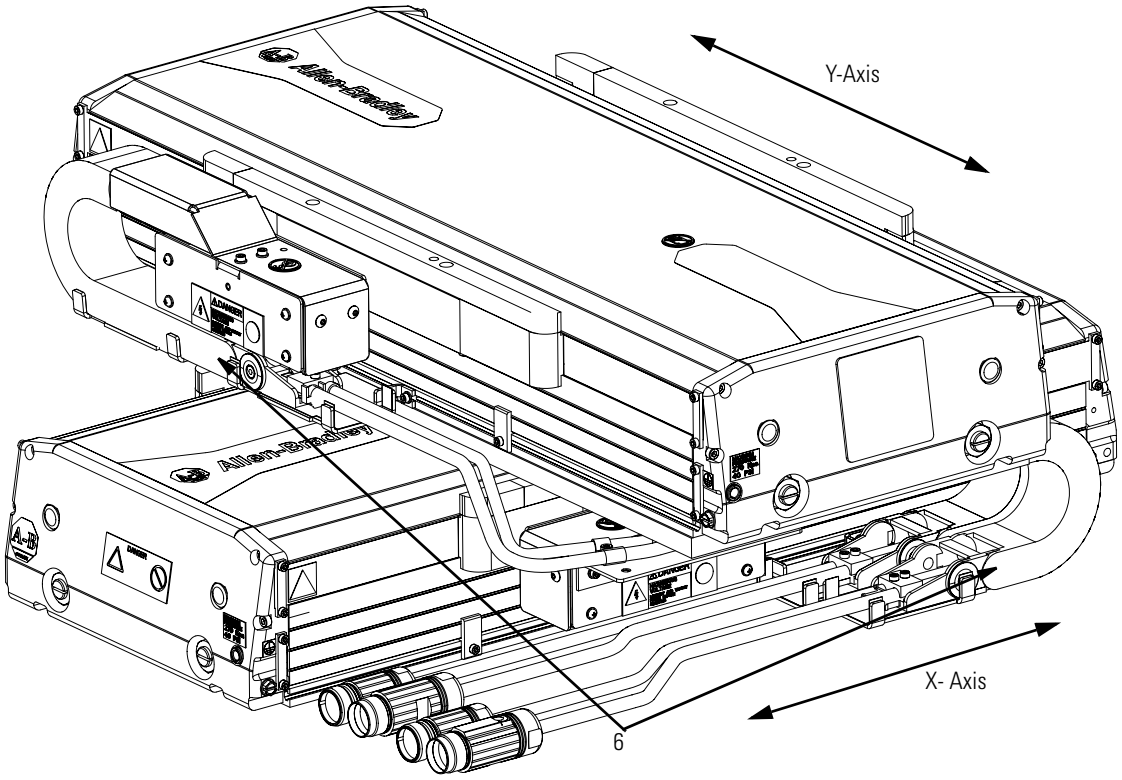
Bulletin Number

(1) Applies to all stages.

Identifying the Components of Your Multi-axis Stage

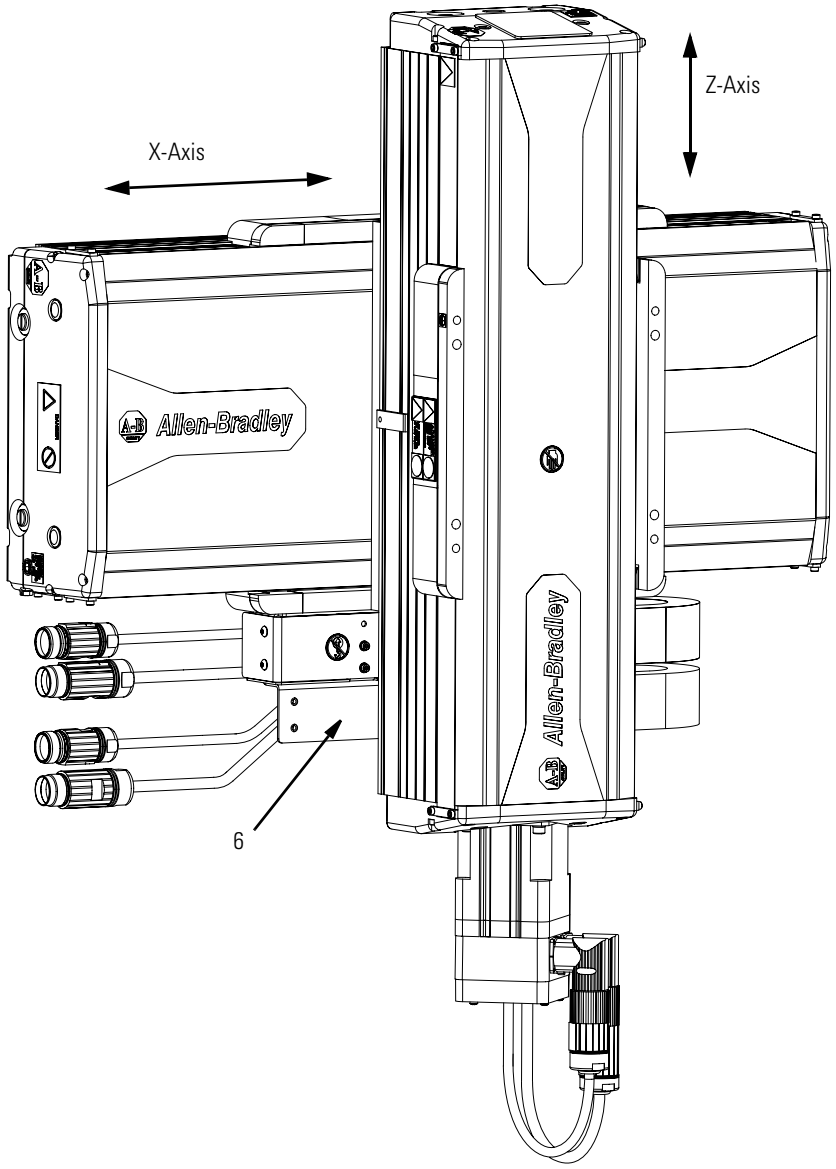
Use the diagrams and descriptions to identify the unique components of the multi-axis stage then refer to Identifying the Components of Each Linear Stage for details of the each linear stage component.

Figure 3 - Components of XY Center Stacked Multi-axis Stage (MPMA- *xAxxxxxxx*-S*x*C shown)



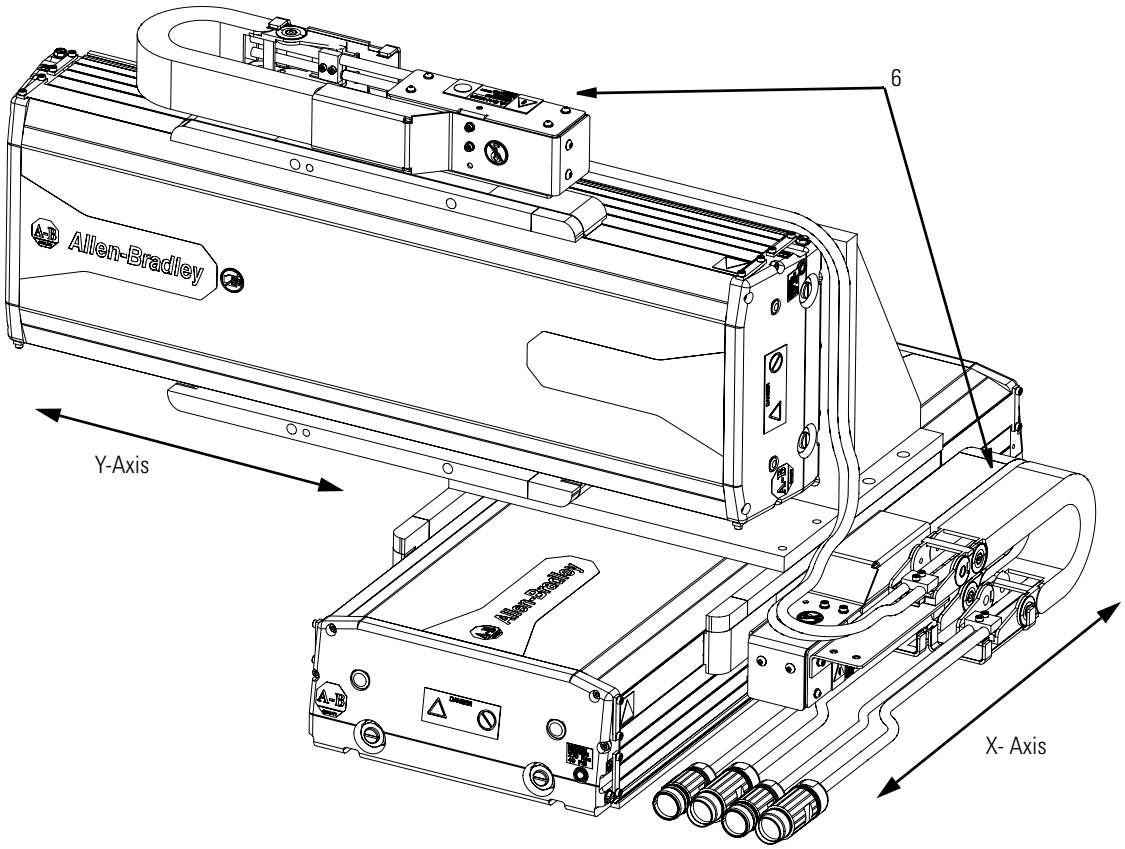
Refer to Component Descriptions beginning on page 23 for the name and description of each numbered item.

Figure 4 - Components of XZ Center Stacked Multi-axis Stage (MPMA-*x*B*xxxxxx*-S*x*C shown)



Refer to Component Descriptions beginning on page 23 for the name and description of each numbered item.

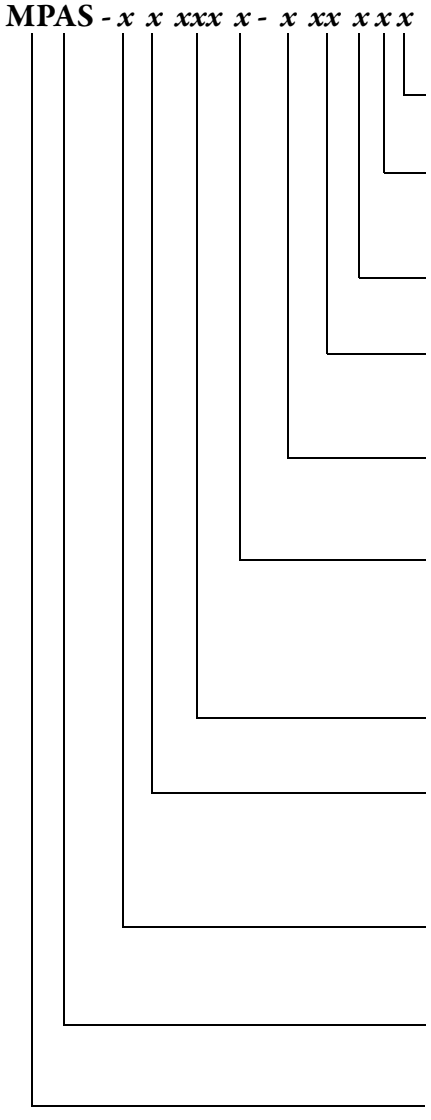
Figure 5 - Components of XY Cantilevered Stacked (Left Side Cantilever) Multi-axis Stages
(MPMA- *x*C*xxxxxxx*-S*x*C shown)



Refer to Component Descriptions beginning on page 23 for the name and description of each numbered item.

Identifying the Individual Linear Stages in Your Multi-axis Stage

Use the following key to identify each linear stage and its options.



Cable

X = Cable carrier module identified at multi-axis level

Brake

2 = No brake
4 = 24V DC brake

Cover

S = Covered with strip seals (IP30 protection)

Screw Lead/Direct Drive

20 = 20.0 mm/rev (0.79 in./rev) ball screw
LM = Direct drive linear motor

Feedback

V = Multi-turn high resolution encoder (absolute feedback) 128 cycles/rev
A = 5 micron resolution incremental magnetic linear encoder

Mechanical Drive/Motor Type

2 = Ball screw/MPLS-*x*220H-VJ4*xxx*
B = Direct drive/LZ-030-T-240-D
E = Direct drive/LC-050-200-D
F = Direct drive/LC-050-200-E
K = Direct drive/LC-075-200-D
L = Direct drive/LC-075-200-E

Stroke Length

xxx = *xxx* cm

Frame Size

6 = 150 mm (5.9 in.) base width
8 = 200 mm (7.9 in.) base width
9 = 250 mm (9.9 in.) base width

Voltage Rating

A = 230V AC
B = 460V AC

Series Type

AS = Actuator, linear stage

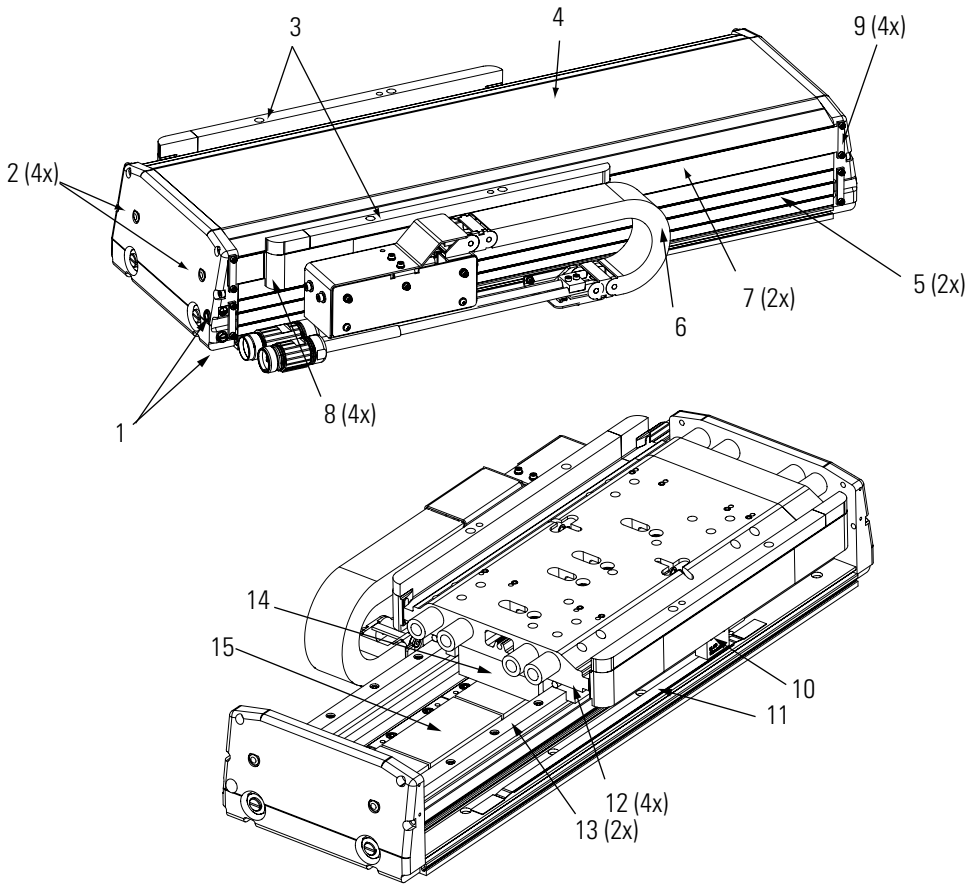
Bulletin Number

Identifying the Components of Each Linear Stage

Use the diagrams and descriptions to identify individual components of each linear stages.

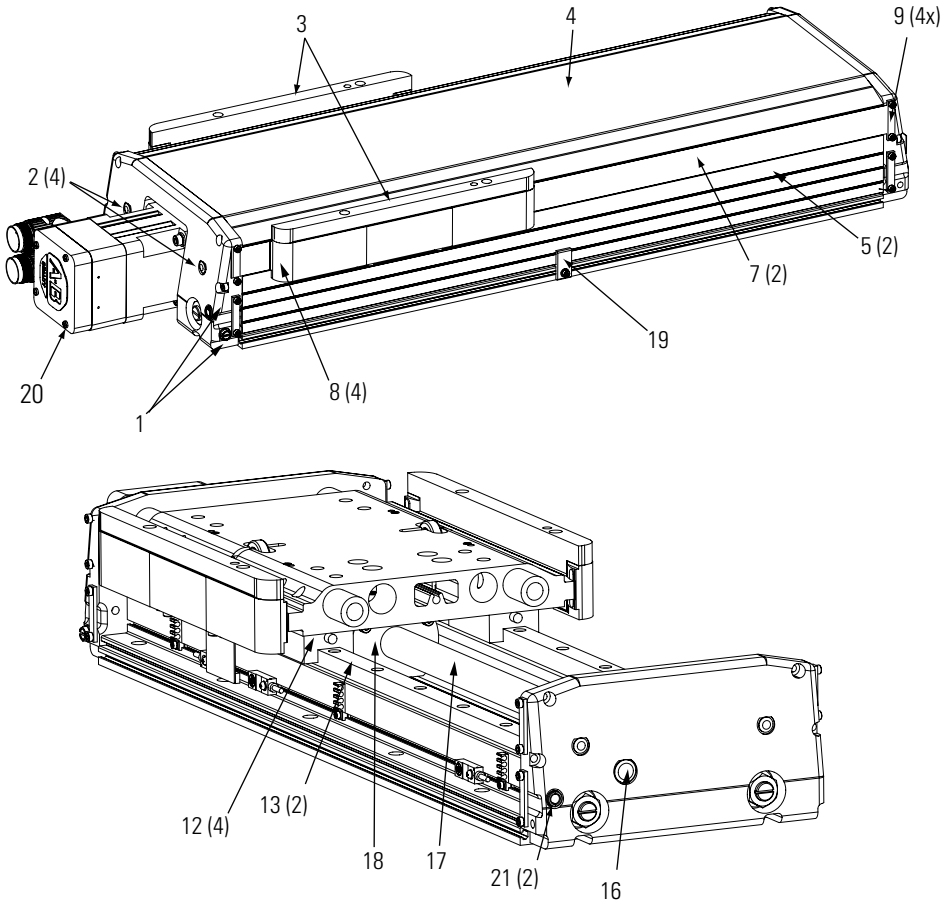
Not all components are part of the direct drive or the ball screw linear stage. For example, the direct drive linear stage does not have component - Rotary Motor and the ball screw linear stage does not have component 15 - Magnet Track.

Figure 6 - Components of the Direct Drive Linear Stage (MPAS-*xxxxxxx*-ALM*x2x*)



Refer to Component Descriptions beginning on page 23 for the name and description of each numbered item.

Figure 7 - Components of the Ball Screw Linear Stage (MPAS-*xxxxxx*-V*xx*S*xx*)



Refer to Component Descriptions beginning on page 23 for the name and description of each numbered item.

Component Descriptions

Component Number	Component	Description
1	Ground Screw and Ground Label	Use the labeled M5 x 0.8 - 6H ground screw to connect the linear stage to a facility safety ground.
2	Bearing Lubrication Ports	These capped ports provide access to the linear bearings without dismantling the linear stage.
3	Carriage	This is where your load mounts. The carriage has mounting holes and pilot guide holes.
4	Top Cover	This protective cover has magnetic edges that keep the upper edge of the strip seals in place.
5	Side Cover	These protective covers have magnetic edges that keep the lower edge of the strip seal in place.
6	Cable Track Module	This assembly may be a single or double track unit. It contains the power and I/O wiring for base linear stage and the secondary axis. Multi-axis stages with direct drive base and secondary axes will have a double cable carrier on the base axis and a single carrier on the secondary axis. The cable carrier replacement modules come as a complete unit that service the base and secondary axes. It facilitates quick and easy replacement of this wear item and is available as a spare part.
7	Stainless Steel Strip Seal	These replaceable flexible stainless steel strips permit the linear stage to move while isolating the internal mechanism of the linear stage from the users environment. Keep the strip seals clean, and never apply a lubricant as this attracts contaminants.
8	Seal Guide	These guides allow the strip seal to move smoothly around the carriage of the linear stage.
9	Seal Strip Clamps	These clamps hold the strip seal in place. When replacing the seal strips, they are used to position it so it lays smooth against the top and side covers.
10	Magnetic Encoder Readhead	This encoder readhead has a 5 micron resolution and very low maintenance needs.
11	Encoder Strip	Part of the encoder system that provides magnetic encoded polarities to the encoder readhead.
12	Bearing	These support bearings guide the carriage on the bearing rail and require periodic lubrication.
13	Bearing Rail	These rails provide the linear track that the carriage assembly rides on, they should be kept free of debris.
14	Motor Coil	This coil is part of the two piece linear motor. When it is excited by a drive, it generates magnetic forces which interact with the magnet track creating motion. LC motor coil shown here. LZ motor coil is a different configuration but works the same way.
15	Magnet Track	This track of powerful static magnets is the other half of a linear motor. LC magnet track shown. LZ has a magnet channel but works the same way.
16	Ball Nut Lubrication Port	This capped port provide access to the ball nut without dismantling the linear stage.
17	Ball Screw Shaft	This is part of the mechanical power system on ball screw linear stages. This shaft should be kept free of debris.
18	Ball Nut	Transfers mechanical power from the ball screw shaft to the carriage. It requires periodic lubrication.
19	Side Cover Support	These supports stabilize the side cover on long linear stages.
20	Rotary Motor	A bulletin MPLS rotary motor drives the ball screw mechanism. It is a specially configured MP-Series rotary motor, and is available as a spare part.
21	Air Port	Provides an external air supply connection for a ball screw linear stage. You can apply a maximum of 270 kpa (40 psi) pressurized air to minimize the ingress of particulates from a dusty environment.

Maintenance Intervals

This section lists typical maintenance intervals for your linear stage, and references the section where maintenance procedures are described.

IMPORTANT	The suggested time period for re-lubrication is only a starting point. You should determine the frequency of re-lubrication that is best suited to your application as an application's environment, motion profile, and duty cycle can effect the re-lubrication time period required.

Lubrication Intervals

Refer to the Maintenance chapter beginning on page 61 for lubrication procedures. Recommended lubrication intervals are:

- direct drive linear stages every 6 months or 2500 km (1550 mi) of travel, whichever comes first
- ball screw linear stages every 6 months or 150,000,000 revolutions, whichever comes first

Cable Carrier Replacement

The cable carrier module assembly has a useful lifetime of approximately 10,000,000 cycles.

Refer to the Removing and Replacing Multi-axis Stage Components chapter beginning on page 65 for removal and replacement procedures.

Planning a Multi-axis Stage Installation

Introduction

Use this chapter to establish a suitable environment and physical location for your multi-axis stage.

Topic	Page
General Safety Standards for Multi-axis Stage Installations	25
UL Safety Standards for Linear Stage Installations	26
Mounting Restrictions	27
Environmental Factors	27
Clearance Requirements	29

Requirements to be met when mounting your multi-axis stage include the following.

General Safety Standards for Multi-axis Stage Installations

General safety standards and requirements include, but are not limited to, the following:

- ANSI/RIA R15.06, Industrial Robots and Robot Systems Safety Requirements - Teaching Multiple Robots
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery
- CSA/CAN Z434, Industrial Robots and Robot Systems- General Safety Requirements
- EN60204-1, Safety of Machinery. Electrical Equipment of Machines

UL Safety Standards for Linear Stage Installations

All linear stage installations should follow Underwriters Laboratories standard UL 1740 - Standard for Safety for Robots and Robotic Equipment.

UL 1740 covers robots and robotic equipment rated at 600V or less and intended for installation in accordance with the National Electrical Code, ANSI/NFPA 70. Because end user installation of a robot and robotic equipment may vary for each user application, guidelines for end-product installation may be evaluated to the applicable sections of ANSI/RIA R15.06, Standard for Industrial Robots and Robot Systems-Safety Requirements. Portions of the requirements in this standard have been excerpted from the Robotic Industries Association's (RIA) Standard for Industrial Robots and Robot Systems – Safety Requirements, ANSI/RIA R15.06.

ANSI/RIA R15.06 specifically requires two safety features be in the design.

- A Power Enable light must be installed that meets all of these conditions:
  - Must be amber or yellow in color.
  - Must not have a screw type base or contain a filament.
  - Must be visible from all approaches to the work cell.
  - Must illuminate to indicate that drive power is available and motion is possible.

  For example, an Allen-Bradley 855T Control Tower Stack Light may be used with socket mount status indicators. Incandescent bulbs are not permitted.
- Provide a means of emergency movement without drive power available. This should include a provision for a brake release on a ball screw linear stage.

  For example, refer to the Emergency Brake Release for Ball Screw Linear Stage Example diagram on page 41.

Unique features or functions associated with the robotic application, not specifically addressed in UL 1740, shall also be evaluated to other applicable standards and requirements. These may include, but are not limited to the following:

- UL 3101-1, Electrical Equipment for Laboratory Use; Part 1: General Requirements
- UL 544, Medical and Dental Equipment
- UL 79, Power Operated Pumps for Petroleum Product Dispensing Systems
- ANSI/NFPA 79, Electrical Standard for Industrial Machinery

Mounting Restrictions

When locating your multi-axis stage include the following:

- Environmental Factors
- Mounting Surface Restrictions
- Mounting Orientations for Center and Cantilever Multi-axis Stage XY (MPMA-*x*A/C*xxxxxx*-S*x*C)
- Mounting Orientations for Center Stacked XZ Multi-axis Stage (MPMA-*x*B*xxxxxx*-S*x*C)
- Clearance Requirements

Environmental Factors

Factor	Applicability
Temperature	The linear stage does not require any special cooling considerations. Avoid mounting it near any heat generating objects, such as a heat register. Sustained average operating temperature should not be greater than 40 °C (104 °F), nor less than 0 °C (32 °F).
Humidity	Avoid excessive humidity that can cause condensation on metal surfaces and consequently stage corrosion. The maximum permissible noncondensing humidity is 80% relative.
Access and interference	When possible, the system should be located where sufficient working space is available to perform periodic maintenance. Avoid installing where a trapping hazard or pinch point occurs as a result of interference with the building, structures, utilities, and other machines and equipment.
Dust and airborne contaminants	Avoid placing the stage in areas where excessive dust or other airborne contaminants are present. Chemical fumes or vapors can cause damage to internal components.
Vibration	The linear stage should be installed in a location free of excessive vibration.
Ambient light	Sufficient light should be readily available to enable inspection, testing, and other functions to be performed on the stage.

Mounting Surface Restrictions

Surface	Restriction
Flatness	X-axis or base stage must be bolted or clamped to a flat, stable, and rigid surface along its entire length. Flatness deviation in the mounting surface should be less than or equal to 0.025 mm over a 300 x 300 mm (0.001 in. over a 12 x 12 in.) area. Flatness should be maintained during operation of the linear stage.

*Mounting Orientations for Center and Cantilever Multi-axis Stage XY (*MPMA-*x*A/C*xxxxxx*-S*x*C*)*

Mounting Orientation	Restriction
Ceiling - inverted surface	A ceiling mount (inverted on a horizontal surface) is not recommended. Stages mounted in this orientation are subject to premature cable carrier failure.
Wall - horizontal vertical or incline	Use only center stacked XZ multi-axis stage for wall mounting applications.

*Mounting Orientations for Center Stacked XZ Multi-axis Stage (*MPMA-*x*B*xxxxxx*-S*x*C*)*

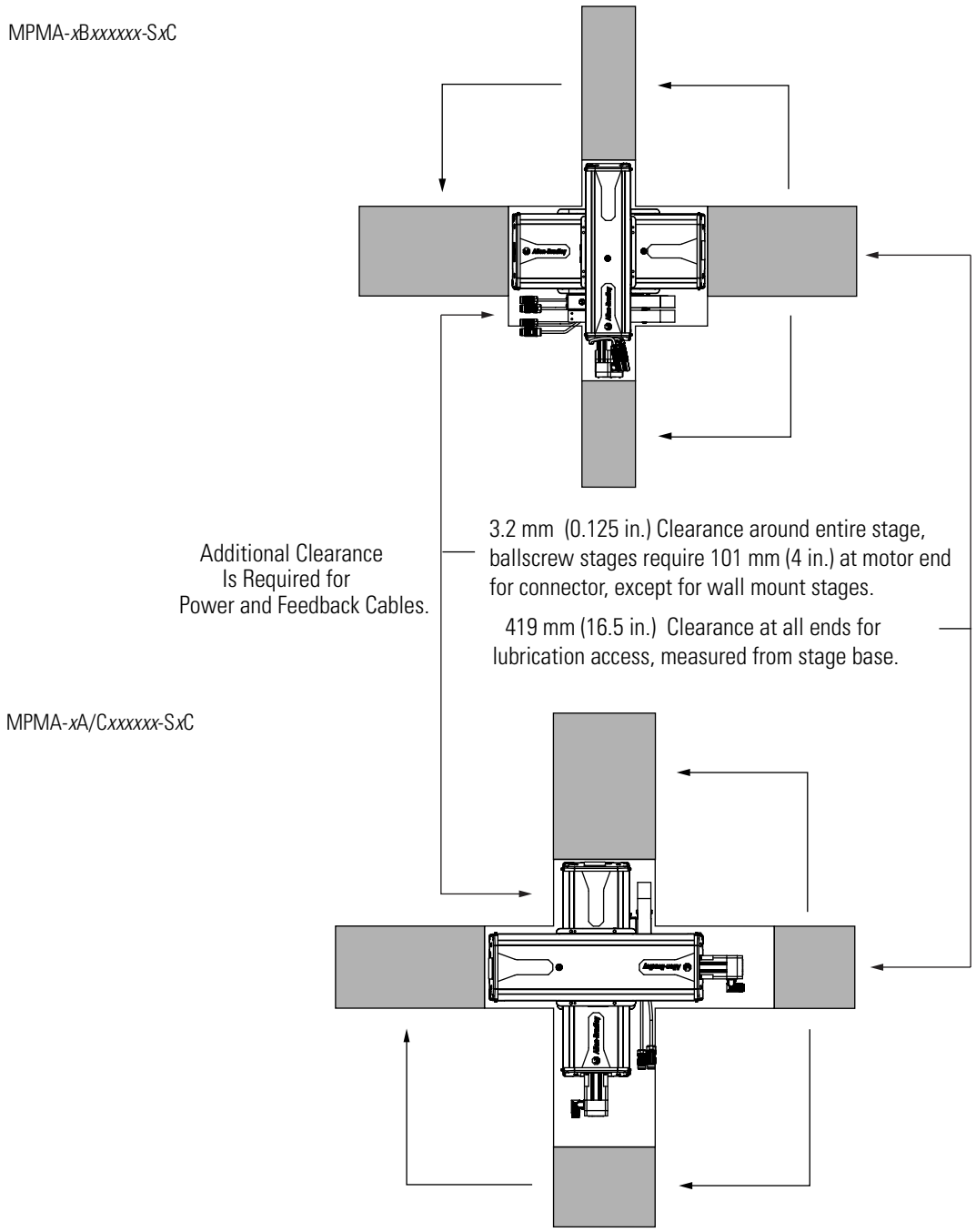
Mounting Orientation	Restriction
Ceiling - inverted surface	A ceiling mount (inverted on a horizontal surface) is not recommended. Stages mounted in this orientation are subject to premature cable carrier failure.
Wall - horizontal vertical or incline	Mount center stacked XZ multi-axis stages with the ball screw driven stage in the Z-axis only. Application of the holding brake through the operating program settings prevents uncontrolled motion.

Clearance Requirements

The figures depict the minimum clearances for each multi-axis stage type.

Power and feedback cables may impose additional clearance requirements. Refer to Interconnect Cables on page 103 for connector and bend radius requirements.

Figure 8 - Minimum Clearance Requirements



Notes:

Mounting and Connecting the MP-Series Integrated Multi-axis Linear Stage

Introduction

This chapter provides unpacking, handling, and mounting instructions.

Topic	Page
Unpacking, Handling, and Inspection	31
Multi-axis Stage Storage	35
Mount the Multi-axis Stage	35
Mount Your Application	36
Connect the Multi-axis Stage	37
About the Air Option for Ball Screw Linear Stages	40
About the Brake Option for Ball Screw Linear Stages	40
Meeting UL Installation Standards	41

IMPORTANT Any person that teaches, operates, maintains, or repairs these multi-axis stages must be trained and demonstrate the competence to safely perform the assigned task.

Unpacking, Handling, and Inspection

Inspect packaging to make certain no damage has occurred in shipment. Any damage or suspected damage should be immediately documented. Claims for damage due to shipment are usually made against the transportation company. Contact Rockwell Automation immediately for further advice.

Be sure the information listed on the purchase order correlates to the information on the packing slip for your linear stage and its accessories. Inspect the assemblies and confirm, if applicable, the presence of specified options.

ATTENTION: Direct drive linear stages contain powerful permanent magnets that require extreme caution during handling. Do not disassemble the linear stage. The forces generated by permanent magnets are very powerful and can cause bodily injury.

Persons with pacemakers or automatic implantable cardiac defibrillators (AICD) should maintain a minimum distance of 0.3 m (12 in.) from magnet assemblies.

Additionally, unless absolutely unavoidable, a minimum distance of 1.5 m (5 ft) must be maintained between magnet assemblies and other magnetic or ferrous composite materials. Calipers, micrometers, laser equipment, and other types of instrumentation must be nonmetallic.

Unpacking Guidelines

Use an overhead lifting device for removing the platform from the shipping crate and lift platform by eyebolts.

ATTENTION: Keep the multi-axis stage horizontal, cantilever multi-axis stages are top-heavy and will fall over if unsupported. To minimize the possibility of it tipping keep the multi-axis stage clamped to the platform until you are ready to install it.

WARNING: Check that the load ratings of the lifting device, slings, hooks and shackles have a lifting capacity rated equal to or greater than the load. Failure to do so may result in personal injury and equipment damage. For your system's specific weight, refer to shipping weights on the packing slip.

Do not pass ropes or cables through the eye bolts in the deck. Use slings with load-rated hooks or shackles.

Lift the system a minimal amount to verify that it is properly secured and balanced before moving the equipment further. The lift points on the deck may not be equidistant from the center of gravity.

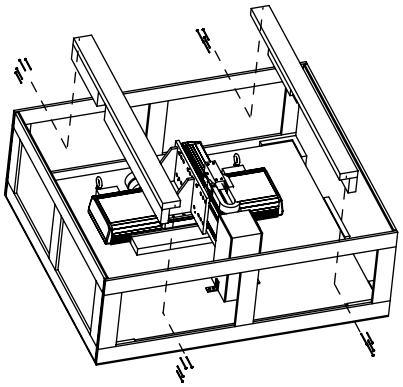
Select or adjust the rigging lengths to compensate for the weight distribution or load. Maintain the system in an upright position.

Unpack the Multi-axis Stage

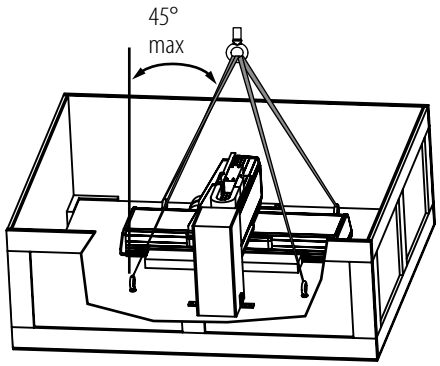
ATTENTION: Improper handling of a multi-axis stage can cause personal injury and damage to the equipment. Follow these unpacking instruction to safely unpack and avoid damaging your multi-axis stage.

The following procedure show you how to safely remove the stack stage from its shipping crate.

1. Remove the crate cover and baces.

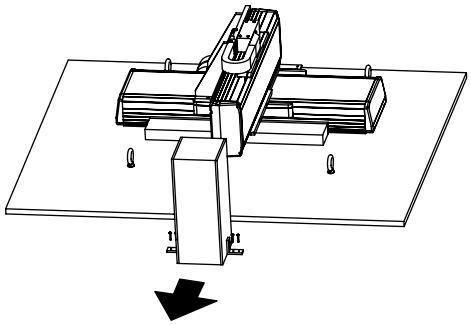


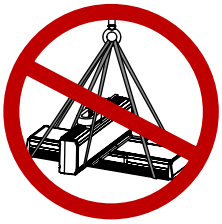
2. Attach lifting straps to shipping platform eyebolts. The angle between straps and vertical is not to exceed 45°.



3. Lift platform from crate using a hoist.

4. Support cantilevered or secondary stage while removing crate shipping platform.



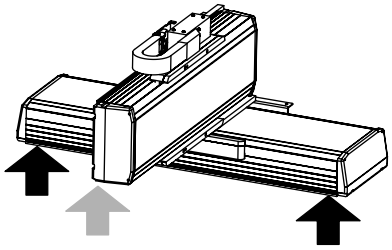


ATTENTION: Never use lifting straps to move the multi-axis stage. Using lifting straps will deform covers and strip seals. Always use a three-person lift to move the multi-axis stage.

Use a three-person lift to move the multi-axis stage.

Three-Person Lift - One person at each end of base stage grasping the bottom of the stage near the ends. The third person will grasp the cantilevered end or top stage by the stage base only and apply only enough lift to balance the equipment.

The bottom stage should bare most of the weight and the top used for balance only. Do not lift by the cover, side covers, or put pressure on the strip seals.



WARNING: Do not remove stage shipping brackets until multi-axis stage is fully installed. Removing stage shipping brackets will allow the carriages to move unexpectedly which could cause personal injury and damage to the equipment.

5.

WARNING: Improper lifting of this product may result in personal injury or damage equipment, never attempt to lift or move the multi-axis stage by means other than those listed in this publication.

Store Packaging Material

Keep the crate and packing materials in case the multi-axis stage needs to be returned for warranty service or stored for an extended period of time.

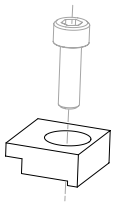
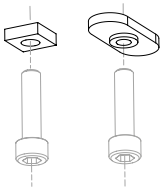
1. Tape screws and clamp hardware to the plywood board brace.
2. Put the end caps and braces in their original positions and place all packing material inside the crate.

Multi-axis Stage Storage

The multi-axis stage storage area should be clean, dry, vibration free, and have a relatively constant temperature. Refer to Environmental Specifications for Multi-axis Stages on page 101 for more detailed information.

Mount the Multi-axis Stage

Follow these steps to install a multi-axis stage on its mounting surface using the supplied tee nut bars. Refer to Specifications and Dimensions beginning on page 81 for detailed mounting dimensions and the number of fasteners required.

Fastener	Order	Illustration	User Supplies[4]	Recommended For	Torque N•m (lbf•in)
Through Bolt[1]	–		M5 x 1.0 x 16 mm min	Uncovered stages	3.4 (30)
Toe clamps	MPAS-TOE		M6 x 1.0 x 16 mm min	Covered stages	5.5 (48)
Tee nuts[2]	MPAPS-*x*-TNUT[3]		M6 x1.0	Securing a stage from beneath the mounting surface.	Tee Nut 5.5 (48) Square Nut 2.3 (30)

(1) Through bolt mounting is not an option for catalog number MPAS-*x*6*xxxx*-*x*LM*xxx* (150 mm) stages.
(2) The tee nut mount for a catalog number MPAS-*x*8*xxxx*-*xxxxx* (200 mm) stage is a square nut in a tee slot.
(3) Where *x* is the frame size of a stage, 6 = MPAS-*x*6*xxxx*-*xxxxx* (150 mm), 8 = MPAS-*x*8*xxxx*-*xxxxx* (200 mm), 9 = CHPS-*x*9*xxxx*-*xxxxx* (250 mm).
(4) You supply the bolts.

1. Be sure the mounting surface is clear of any and all foreign material.

IMPORTANT	Do not use abrasives to clean the surface.

If necessary, stone the mounting surface (acetone or methanol may be applied as cleaning agent).

2. Verify the flatness of the surface to which the linear stage is to be mounted.

The total indicator reading (TIR) is 0.0254 mm (0.001 in.) per 300 mm (12 in.). TIR or runout, correlates to an overall flatness of a surface.

ATTENTION: Do not attempt to move the multi-axis stage by grasping a cable junction box. Moving the multi-axis stage in this manner will damage it and create a pinch or crush hazard. The junction box is attached to the carriage, which is free to move. Lifting the multi-axis stage in this manner allows uncontrolled movement of the heavy base.

Always use a three-person lift and grasp the multi-axis stage by the base axis at the end caps Keeping fingers clear of the upper axis and it carriage's path of travel.

Personal injury and equipment damage may occur if the linear stage is handled improperly.

3. Lift the multi-axis stage onto and the prepared mounting surface and align.
4. Insert the supplied tee nut bar and center it in the T-slot, long stages will require multiple tee nut bars, be sure to install tee nut bars in both T-slots.
5. Secure the linear stage by using all mounting holes. Torque all mounting bolts to 3.2 N•m (48 lb•in).

Mount Your Application

Mount your application to the carriage using the following bolts and torque values:

Cat. No.	Bolt	Torque N•m (lb•in)
MPAS-*x*6*xxxx-xxxxxx*	M6	3.2 (48)
MPAS-*x*8*xxxx-xxxxxx*	M8	10.1 (90)
MPAS-*x*9*xxxx-xxxxxx*	M8	10.1 (90)

Connect the Multi-axis Stage

The installation procedure assumes you have prepared your system for correct electrical bonding and understand the importance of electrical bonding for correct operation of the system to which your linear stage belongs. If you are unfamiliar with electrical bonding, the section Attach the Ground Strap and Interface Cables briefly describes and illustrates correct system grounding techniques.

ATTENTION: Plan the installation of your multi-axis stage so that you can perform all cutting, drilling, tapping, and welding before installing the multi-axis stage. Be careful to keep any metal debris from falling into the stages. Metal debris or other foreign matter can become lodged in a stage, which can result in damage to the stage or its components.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the multi-axis stage prior to applying power. Once power is applied, connector terminals may have voltage present even when not in use.

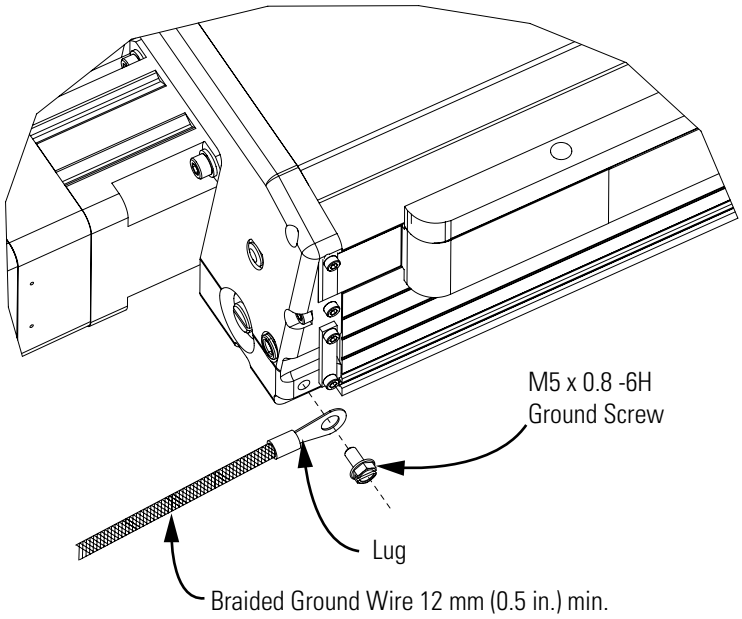
Attach the Ground Strap and Interface Cables

A ground strap and four cable connections are the only electrical connections necessary between the multi-axis stage and the drive system. The flat surfaces on the power and feedback connectors should align during connection, and significant resistance should not be felt when tightening either connector.

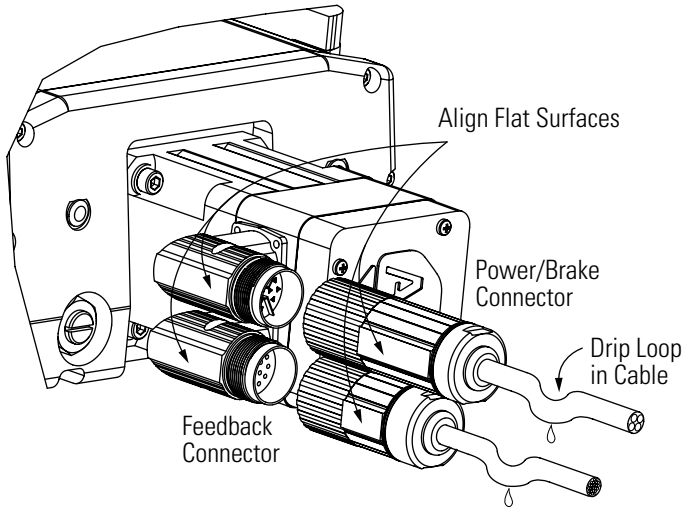
1. For electrical safety, connect the ground screw on the chassis of the lower linear stage to the groundbus for your system.

   To reduce the effects of electromagnetic interference (EMI), bond the stage with a braided ground strap, 12 mm (0.5 in.) wide minimum, to a grounded metal surface. This creates a low-impedance return path for high-frequency energy.

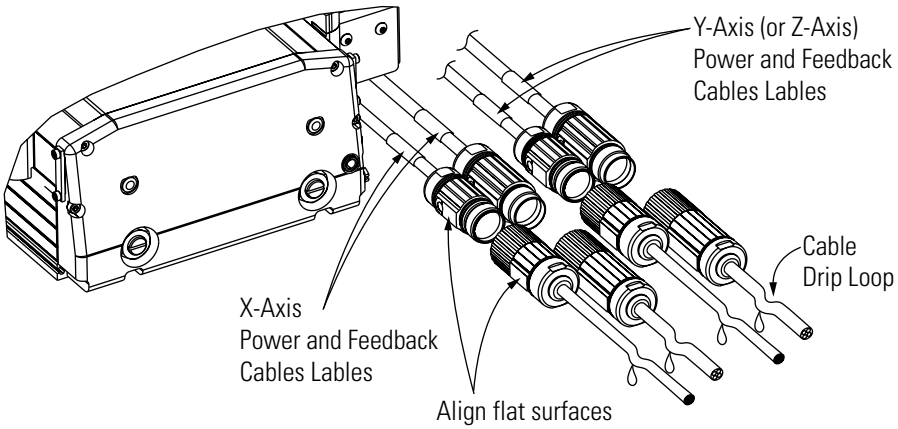
2. Torque the ground screw at the lower stage to 2 N•m (18 lb•in.).



3. Form a drip loop in each cable at a point directly before it attaches to the motor.



OR



4. Identify the multi-axis stage power and feedback cables by the labels near the connector.
5. Attach the feedback cable, and the combination power and brake cable to the motor.

ATTENTION: Do not connect or disconnect the motor feedback cable, or the power and brake cable while power is applied to them.

Inadvertent pin connections may result in unexpected motion or result in irreversible damage to the components.

a. Carefully align each cable connector with the respective motor connector as shown in the diagram.
b. Do not apply excessive force when mating the cable and motor connectors.

   If the connectors do not go together with light hand force, realign and try again.

ATTENTION: Be sure that cables are installed and restrained to prevent uneven tension or flexing at the cable connectors. Excessive and uneven lateral force at the cable connectors may result in the connector's environmental seal opening and closing as the cable flexes. Failure to observe these safety procedures could result in damage to the motor and its components.

c. Hand tighten the knurled collar five to six turns to fully seat each connector.

ATTENTION: Keyed connectors must be properly aligned and hand-tightened the recommended number of turns.

Improper alignment is indicated by the need for excessive force, such as the use of tools, to fully seat connectors.

Connectors must be fully tightened for connector seals to be effective.

Failure to observe these safety procedures could result in damage to the motor, cables, and connector components.

About the Air Option for Ball Screw Linear Stages

A ball screw linear stage may connect to an external air supply via the air port; see Component Descriptions on page 23. This can reduce the ingress of particulates in a dusty environment.

- Air supplied to the ball screw stage should not exceed 10 kpa (1.45 psi).
- Plastic air tubing should be 6 mm (0.2362 in.) OD Teflon FEP tubing.
- If using only one port, plug other port.
- Maximum flow rate 15 SCFM based on 4mm ID tube and 0.5m max length.

About the Brake Option for Ball Screw Linear Stages

The brakes offered as options on the ball screw linear stages are holding brakes. They are designed to hold the carriage in place up to the rated brake holding force. The brakes release when voltage is applied to the brake coil. Voltage and polarity supplied to the brake must be as specified to be sure of proper brake performance.

The brakes are not designed to stop the movement of a linear stage. Servo drive inputs should be used to stop motion. The recommended method of stopping motion is to command the servo drive to decelerate to 0 mm/s (0 in/s), and engage the brake after the servo drive has decelerated the linear stage to 0 mm/s (0 in/s).

If system main power fails, the brakes can withstand use as stopping brakes. However, use of the brakes as stopping brakes creates rotational mechanical backlash that is potentially damaging to the system, increases brake pad wear, and reduces brake life. The brakes are not designed nor are they intended to be used as a safety device.

Meeting UL Installation Standards

Multi-axis stage installations should follow Underwriters Laboratories standard UL 1740 - Standard for Safety for Robots and Robotic Equipment.

Refer to UL Safety Standards for Linear Stage Installations on page 26 for a brief description of this standard.

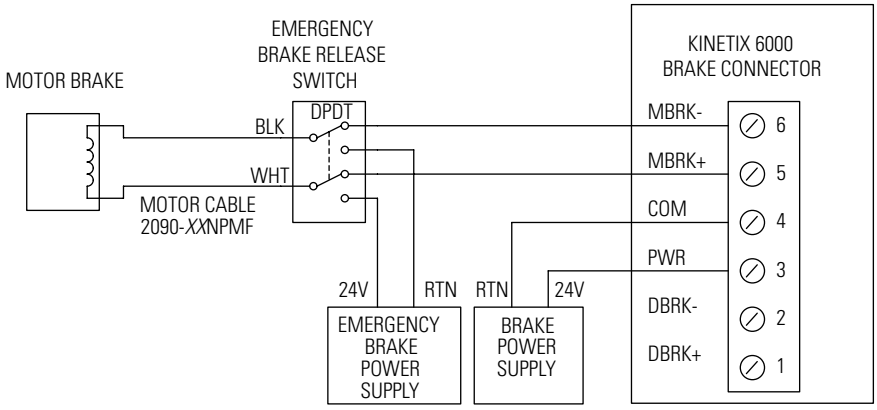
ATTENTION: UL 1740 requires all linear stage installations be equipped as described below.

The design, operation, and verification of this implementation is the machine builders responsibility.

A Power Enable light that illuminates when drive power is applied and motion is possible.

Emergency movement must be possible when drive power is not available to a ball screw linear drive with a brake. The figure depicts an operator controlled circuit for a Kinetix 6000 drive that applies emergency power to release the brake.

Figure 9 - Emergency Brake Release for Ball Screw Linear Stage Example



Notes:

Linear Stage Connector Data

Introduction

This chapter provides power and feedback cable information for the linear stage.

Topic	Page
Linear Stage Power and Feedback Connections	43

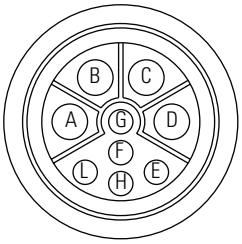
Linear Stage Power and Feedback Connections

The following tables identify the power and feedback pinouts for circular connectors for used with standard Allen-Bradley cables.

The direct drive and ball screw linear stages use different encoder types. Consequently, the feedback connector signals are different for each of these linear stage types.

Table 1 - Power Connector

Pin	Color (1)	Signal
A	Red	U (A) Phase
B	White	V (B) Phase
C	Black	W (C) Phase
D	Green/Yellow	Ground
F	White	Brake+ (2)
G	Black	Brake- (2)
Case	Shield	Cable Shield and GND



Intercontec P/N BKUA090NN000550003500
Mating Cable Allen-Bradley 2090-XXNPMF-16S*xx*

(1) These are the wire colors for the leads on the direct drive linear stages (catalog number MPAS-*xxxxxx*-ALM*x*2X). Wires for the ball screw linear stages (catalog number MPAS-*xxxxxx*-V0*xx*S*x*X) are not field accessible. Refer to Accessories on page 103 for wire colors of interconnect cables.

(2) Brake+ and Brake- are available only on ball screw linear stages having a rotary motor with a brake.

ATTENTION: Disconnect input power supply before installing or servicing stage.

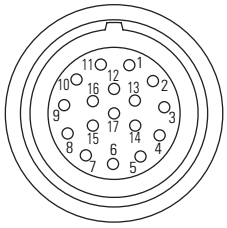
Properly ground the stage as described in this manual and the drive manual.

Table 2 - Feedback Connector for Direct Drive Linear Stage

Pin	Signal Name	Wire Color (2)	Signal Description
1	AM+	Yellow	A Quad B TTL - A Differential
2	AM-	White/yellow	A Quad B TTL - A Differential
3	BM+	Brown	A Quad B TTL - B Differential
4	BM-	White/Brown	A Quad B TTL -B Differential
5	IM+	Violet	TTL - Index Mark Differential
6	IM-	White/Violet	TTL - Index Mark Differential
7	Reserved	–	–
8			
9	+5V DC	White/Red	Encoder and Hall Sensor Power
10	Common	Black	Common
11	Reserved	–	–
12			
13	PTC Temp+ (1)	Green	PTC Thermistor
14	Common	White/Black	Common
15	S1	White/Green	TTL - Trapezoidal Hall Commutation
16	S2	Blue	TTL - Trapezoidal Hall Commutation
17	S3	White/Blue	TTL - Trapezoidal Hall Commutation
Case	Shield	–	–

(1) PTC Temp- is connected to Common.

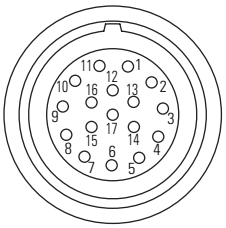
(2) These are the wire colors for the leads on the direct drive linear stages (catalog number MPAS-*xxxxxx*-ALM*x*2X).
Refer to Accessories on page 103 for wire colors of interconnect cables.



Intercontec P/N AKUA034NN00100035000
Mating Cable Allen-Bradley 2090-XXNFMF-S*xx*

Table 3 - Feedback Connector for Ball Screw Linear Stage

Pin	Signal Name MPAS-A*xxxxx* (230V)	Signal Description	Signal Name MPAS-B*xxxxx* (460V)
1	Sin+	Analog Differential 1V p-p	Sin+
2	Sin-	Analog Differential 1V p-p	Sin-
3	Cos+	Analog Differential 1V p-p	Cos+
4	Cos-	Analog Differential 1V p-p	Data-
5	Data+	Serial Data Differential Signal +	Data+
6	Data-	Serial Data Differential Signal -	Data-
7	Reserved	–	Reserved
8			
9	+5V DC	230V MPAS Encoder Power	
10	Common	230V MPAS Encoder Common	
11	Reserved	460V MPAS Encoder Power	+9V dc
12		460V MPAS Encoder Common	Common
13	TS+	PTC Thermistor	TS+
14	TS-	Common	TS-
15	Reserved	–	Reserved
16			
17			
Case	Shield	–	Shield



Intercontec P/N AKUA034NN00100035000
Mating Cable Allen-Bradley 2090-XXNFMF-S*xx*

Notes:

Configuration Guidelines

Introduction

Your multi-axis stage is made from individual MP-Series Integrated Linear Stages. This chapter provides guidelines for using RSLogix 5000 software to configure a servo drive system with an Allen-Bradley MP-Series linear stage. Use this section to configure the individual stages.

Topic	Page
Required Files	47
Configure Your Linear Stage	48
Configure RSLogix 5000 Software for Linear Stages with Kinetix Multi-axis Drives	49
Configure Ultraware Software for Linear Stages with Ultra3000 Drives	58
Set Travel Limits	60
Program Home to Torque for Kinetix Multi-axis Drives with Linear Stages	60

Required Files

Firmware revisions and software versions required to support the linear stages include the following:

- RSLogix 5000 software, version 16.00 or later
- Kinetix 2000 or Kinetix 6000 multi-axis drives
  - Firmware revision 1.96 or later
  - For RSLogix 5000 software, version 16.*xx* use Motion Database file, version 4_13_0 or later
  - For RSLogix 5000 software, version 17.*xx* or later use Motion Database file, version 5_4_0 or later
- Ultra3000 drives
  - Firmware revision 1.52 or later
  - Motion Database (.mdb) file, dated July 2007 or later
- Motion Analyzer software, version 4.4 or later

Download these files from http://support.rockwellautomation.com. Contact Rockwell Automation Technical Support at (440) 646-5800 for assistance.

Configure Your Linear Stage

Configure the linear stage by using the parameter settings described in this chapter.

ATTENTION: Moving parts can injure. Before running the stage, make sure all components are secure.

Check that the linear stage is clear of foreign matter and tools. Objects hit by the moving stage can cause personnel injury or damage to the equipment.

Incorrect motor, Hall, or encoder wiring can cause uncontrolled motion.

IMPORTANT You are responsible to verify that the servo control system safely controls the linear stage with regard to maximum force, acceleration, and speed.

The type of Allen-Bradley drive connected to the linear stage determines the configuration procedure. Refer to the following table to determine the configuration procedures to follow.

If your servo drive is	Start on page	Continue with page
Kinetix 2000 (2093-*xxxx-xxx*)	49	60
Kinetix 6000 (2094-*xxxx-xxx-x*)	49	
Ultra3000 SERCOS (2098-DSD-*xxxx*-SE)	49	N/A
Ultra3000 non-SERCOS (2098-DSD-*xxxx*)	58	

IMPORTANT If you are using a Kinetix 2000 or Kinetix 6000 drive, you will find it useful to read and apply Appendix D, Home to Torque-level Example, to your system-level program.

This appendix provides information on using torque-level homing to reference a known (home) position by monitoring torque while driving an axis into a mechanical hard-stop.

Configure RSLogix 5000 Software for Linear Stages with Kinetix Multi-axis Drives

The RSLogix 5000 software parameters provide here are for basic setup and tuning parameters of MP-Series Integrated Linear Stages.

- In Set Axis Properties in RSLogix Software the drive parameters tables for direct drive and ball screw drive linear stage are shown.
- In Tuning Linear Stages with RSLogix 5000 Software which begins on page 53 follow tasks are covered:
  - Tune Your Linear Stage – for ball screw stages only
  - Calculate and Configure the Loop Gain – for ball screw stages only
  - Set Travel Limits - for direct drive and ball screw stages

Set Axis Properties in RSLogix Software

Use parameter settings in the following table when you configure the ControlLogix drive system for your linear stage. Parameter settings differ between the direct drive and ball screw linear stages be sure to use the correct table. It is assumed the MP-Series linear stage and a Kinetix 2000 or Kinetix 6000 servo drive are installed and wired as one axis of a motion system.

ATTENTION: Incorrect parameter settings may result in uncontrolled motion, with the potential for damage to the stage and machine.

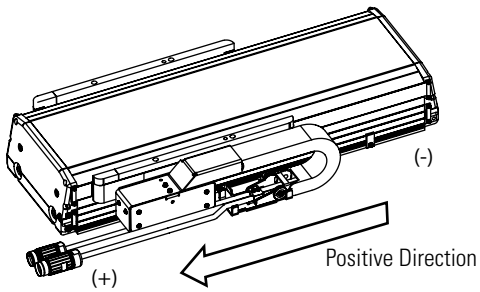
Do not set the Positioning mode to Rotary for any linear stage. This will result in incorrect positioning of the linear stage.

Initiating a motion command on a linear stage with an incorrect Position mode setting may result in damage to the linear stage, and the machine in which it is installed.

Direct Drive Linear Stages

Enter these parameters in the Axis Properties tab of RSLogix 5000 software for direct drive linear stages, catalog number MPAS-*xxxxxx*-ALM*x*2*x*

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Metric	English
Drive/Motor	Motor Catalog Number	Select one from the list *x*MPAS-A6*xxx*B-ALMS2*x* *x*MPAS-A8*xxx*E-ALMS2*x* *x*MPAS-A9*xxx*K-ALMS2*x* *x*MPAS-B8*xxx*F-ALMS2*x* *x*MPAS-B9*xxx*L-ALMS2*x*	
	Drive Resolution	200	
	Drive Counts per	Motor Millimeter	
Motor Feedback	Feedback Type	TTL with Hall	
	Cycles	50	
	Per	Millimeter	

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Metric	English
Conversion	Positioning Mode	Linear	
	Conversion Constant	200 drive counts / 1.0 mm	5080 drive counts / 1.0 in.
Hookup [1]	Test Increment	70 mm, min for Ultra3000 drive 20 mm Kinetix 2000 drive 20 mm Kinetix 6000 drive	2.76 in. min for Ultra3000 drive 0.787 in. Kinetix 2000 drive 0.787 in. Kinetix 6000 drive
	Drive Polarity	Positive  	
Homing	Mode	Active	
	Position	0 (or programmable)	
	Offset	5 mm, min	0.2 in., min
	Sequence	Torque Level-to-Marker	
	Direction	Reverse Bi-directional	
	Torque Level	80%, min Greater if the system friction, force, or weight exceeds 80% of the Continuous Force Rating at any point in the range of motion	
	Speed	50 mm/s	1.97 in./s
	Return Speed	10 mm/s	0.39 in./s
Limits	Hard Travel Limits	Check if hardware limits are in use. Use Motion Analyzer to determine the maximum stopping distance in your application to set Negative and Positive Limits	
	Soft Travel Limits	Check Use Motion Analyzer to determine the maximum stopping distance in your application to set Negative and Positive Limits	
	Position Error Tolerance[2]	10 mm	0.394 in.
Gains	Feedforward Velocity Gain	100%	
Tune	Velocity Feedforward[3]	Check	

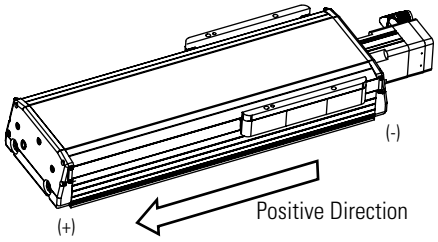
(1) The Command and Feedback test, accessed from the Hookup tab, does not verify the Hall Sensor wiring to a Kinetix 2000 or a Kinetix 6000 drive. The wire colors and continuity for the Hall signals must be manually verified.

(2) Using Auto-tune will reset this parameter to the default value.

(3) Using Velocity Feedforward will reduce position error during motion.

Ball Screw Drive Stages

Enter these parameters in the Axis Properties tab of RSLogix 5000 software for ball screw linear stages, catalog number MPAS-*xxxxxx*-V*xxxxx*.

Axis Properties Tab	**Parameter**	**Entry/Selection, with applicable distance unit settings**	
		Metric	English
Drive/Motor	Motor Catalog Number	Select one from the list MPAS-A*xxxx*1-V05S2*x* MPAS-A*xxxx*1-V05S4*x* MPAS-A*xxxx*2-V20S2*x* MPAS-A*xxxx*2-V20S4*x* MPAS-B*xxxx*1-V05S2*x* MPAS-B*xxxx*1-V05S4*x* MPAS-B*xxxx*2-V20S2*x* MPAS-B*xxxx*2-V20S4*x*	
	Drive Resolution	200,000	
	Drive Counts per	Motor Millimeter	
Conversion	Positioning Mode	Linear	
		ATTENTION: Setting the Positioning Mode to Rotary can cause damage to the stage or the machine due to incorrect positioning.	
	Conversion Constant	10,000 drive counts / 1.0 mm for	254,000 drive counts / 1.0 in. for
Hookup	Test Increment	5 mm min	0.2 in., min
	Drive Polarity	Positive 	
Homing	Mode	Active	
	Position	0 (or programmable)	
	Offset	5 mm, min	0.2 in., min
	Sequence	Torque Level-to-marker	
	Direction	Reverse Bi-directional	
	Torque Level	50%, min Greater if the system friction, force, or weight exceeds 50% of the Continuous Force Rating at any point in the range of motion.	
	Speed	50 mm/s	1.97 in./s
	Return Speed	10 mm/s	0.39 in./s
	Absolute Home is available for ball screw linear stages. For maximum range of motion, position the carriage so its proximal edge is 25.4 mm (1.0 in.) from the inside edge of the end plate.		

Axis Properties Tab	Parameter	Entry/Selection, with applicable distance unit settings	
		Metric	English
Limits	Hard Travel Limits	Check if hardware limits are in use. Use Motion Analyzer to determine the maximum stopping distance in your application to set Negative and Positive Limits	
	Soft Travel Limits	Check Use Motion Analyzer to determine the maximum stopping distance in your application to set Negative and Positive Limits	
	Position Error Tolerance(1)	10 mm	0.394 in.
Gains	Feedforward Velocity Gain	100%	
Tune	Velocity Feedforward(2)	Check	

(1) Using Auto-tune will reset this parameter to the default value.

(2) Using Velocity Feedforward will reduce position error during motion.

Tuning Linear Stages with RSLogix 5000 Software

This section shows the steps to tune linear stages with RSLogix 5000 software, version 16.*xx*.

IMPORTANT	**ATTENTION:** The Tuning and Loop Gain procedures apply only to the ball screw linear stages. The Travel Limit procedures apply to direct drive and ball screw linear stages.

- Tuning your linear stage requires you to calculate and configure the loop gain based on the actual measured inertia.
- By setting travel limits your application minimum deceleration is defined.

Tune Your Linear Stage

IMPORTANT	**ATTENTION:** These procedures apply only to ball screw linear stages.

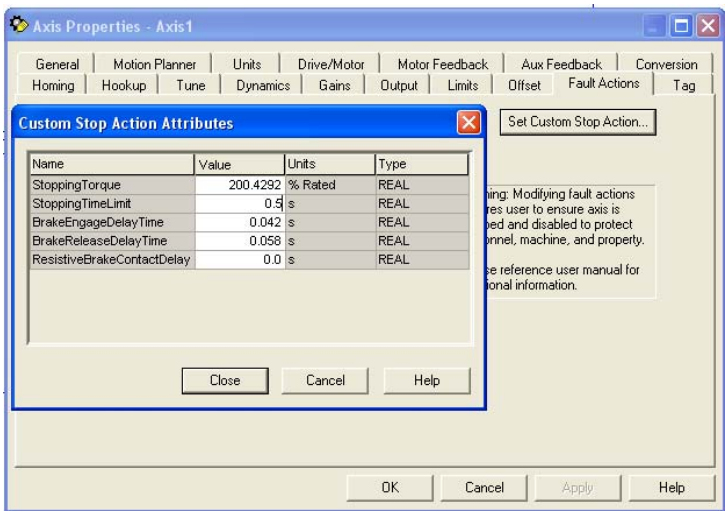
Use the following steps to set the parameters in the Axis Properties tab of RSLogix 5000 software to tune a ball screw drive linear stage (catalog number MPAS-*xxxxxx*-V*xx*S*xx*).

1. In the Axis Properties dialog box, choose Fault Actions tab>Set Custom Stop Action>Custom Stop Attributes.

   TIP These parameter settings work best if the linear stage is installed in a horizontal (table top) or a wall mount (vertical) orientation.

2. Set the Brake Engage and the Brake Release delay times to the values listed in Brake Specifications for Ball Screw Linear Stage Motors on page 101.

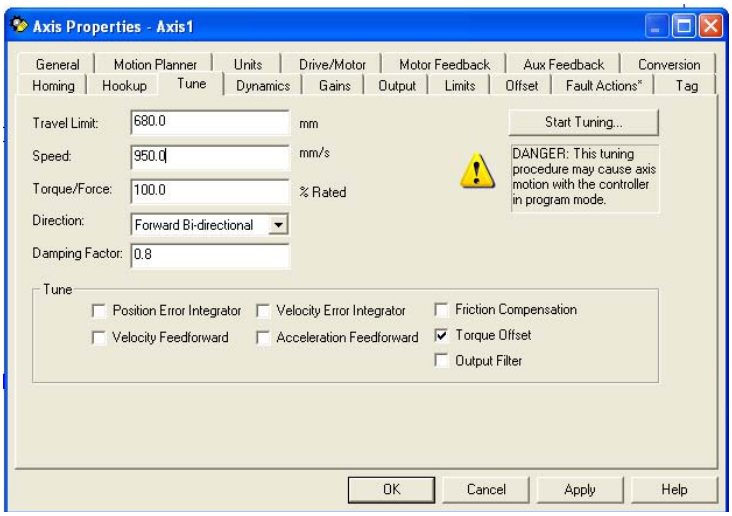
3. Reduce the default Stopping Time Limit from 10 seconds to 0.5 seconds.



IMPORTANT To prevent the carriage from moving, or falling when installed in a vertical orientation, the Stopping Time Limit must be set to 0.99 seconds or less.

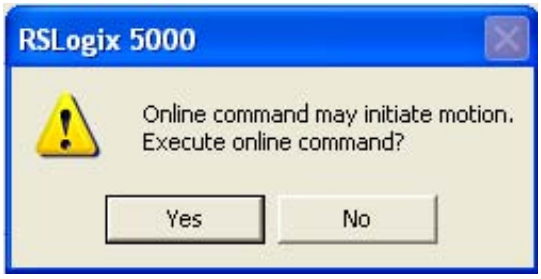
4. Select the Tune tab in the Axis Properties dialog box and enter the following parameters:
   - Travel Limit. Set to a maximum of the travel length of the linear stage.
   - Speed (velocity).
   - Torque/Force.

IMPORTANT Only check Torque Offset, as shown below, if the linear stage is installed in a non-horizontal mount position.



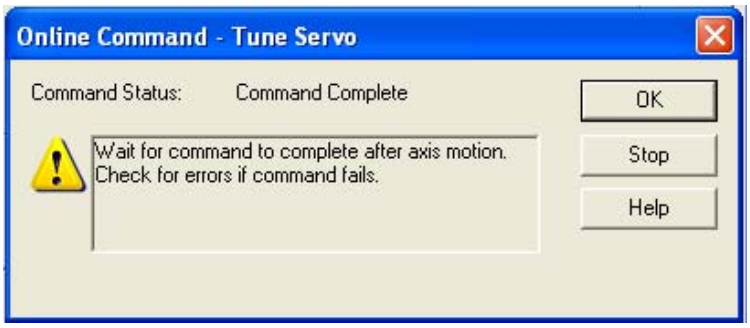
5. On the Tune tab, click Start Tuning to access the Motion Initiation dialog box.

6. Click Yes to begin tuning the linear stage.

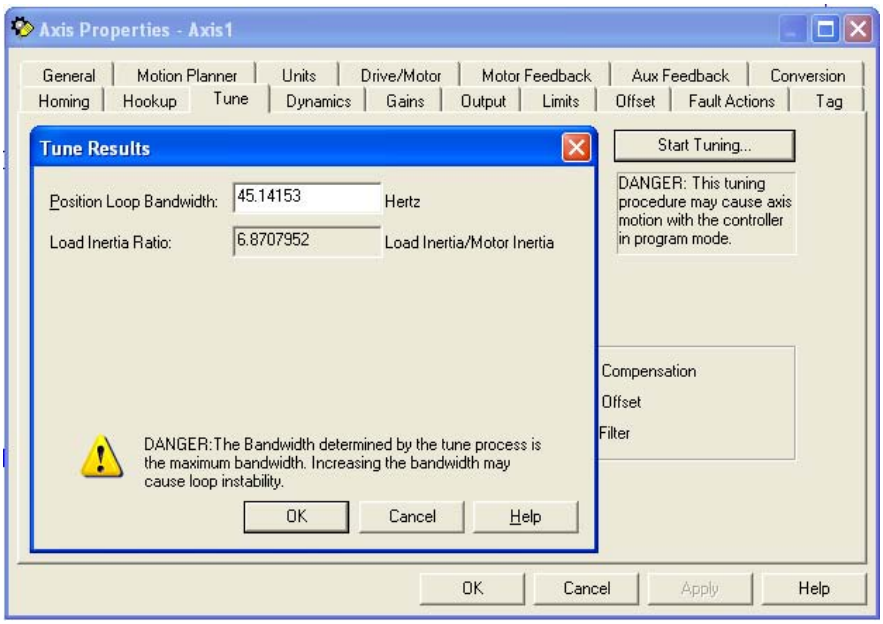


ATTENTION: Motion occurs immediately after clicking Yes.

Tuning is complete when the Tune Servo dialog box appears.



7. Select Yes to exit Tuning, and display the Tune Results dialog box.



Calculate and Configure the Loop Gain

IMPORTANT These Loop Gain procedures apply only to ball screw linear stages.

You must calculate a position loop bandwidth based on the actual measured inertia. This is with the values from the Tune Results dialog box for a ball screw drive linear stage.

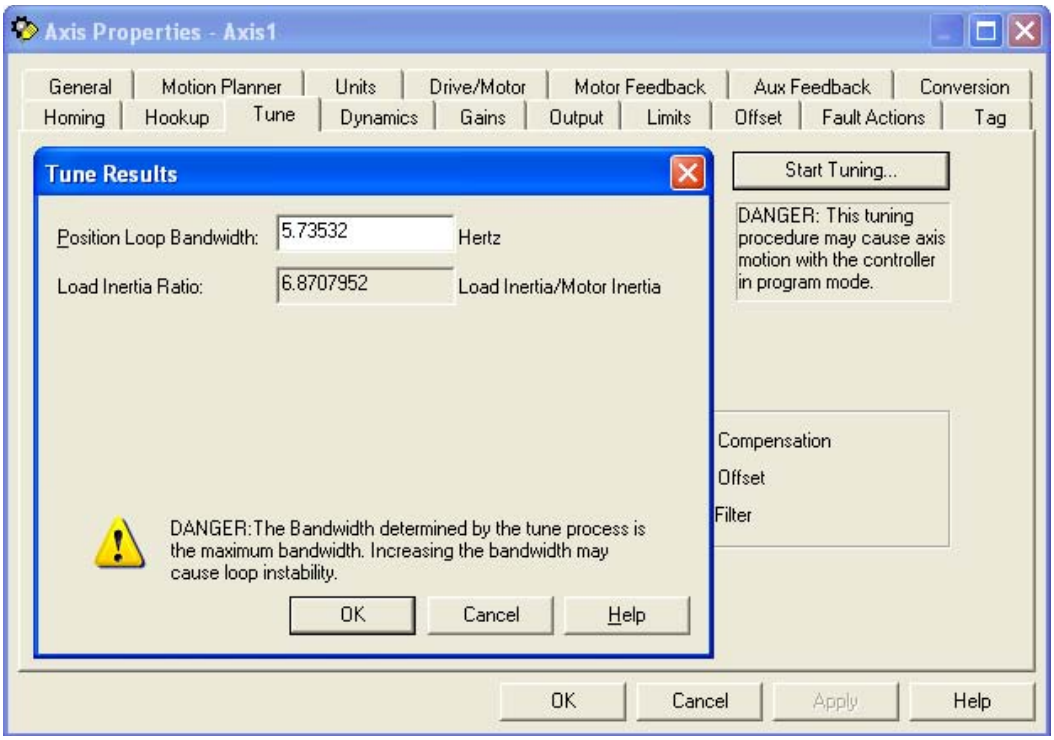
The Tune Results dialog box above shows a default Position Loop Bandwidth of 45.14153 Hz, and a Load Inertia Ratio of 6.8707952.

1. Calculate the Corrected Position Bandwidth as follows:

   Corrected Position Loop Bandwidth = (Initial Position Loop Bandwidth Result/(Initial Load Inertia Ratio Result +1)

   For example, 5.73532 = 45.14153 / 7.8707952.

2. Enter the Corrected Position Bandwidth value 5.73532 as the Position Loop Bandwidth and click OK.



3. Answer the remaining dialog boxes to apply the values.

The proper Position Bandwidth results in a stable starting point, from which you may adjust the gains to fit the application requirements.

Configure Ultraware Software for Linear Stages with Ultra3000 Drives

The following steps assume that the MP-Series linear stage and an Ultra3000 drive are installed and wired as one axis of a motion system.

1. Connect a serial cable model, catalog number 2090-DAPC-D09*xx*, to the CN3 connector on your Ultra3000 drive.
2. Apply AC input power to the Ultra3000 drive.
3. Establish communication with the Ultra3000 drive, and click Cancel when the Ultra3000 motor database dialog box appears.

   Clicking Cancel causes the Ultraware software to scan for online drives. When a drive is found, an Online Drive icon will display in the Workspace.
4. Double-click the Online Drive icon to view the main Drive setup dialog box.
5. Perform the action in the following table appropriate for your type of linear stage:

If your linear stage is a	Do this
Direct drive MPAS-*xxxxxx*-ALMO2*x*	Select your direct drive linear stage from the drop down in the Motor Model dialog box, and then verify the data in the Motor Field is correct for your direct drive linear stage.
Ball Screw *x*MPAS-*xxxxx*-V20S2*x*	Verify the data in the Model Field is correct for your ball screw linear stage.

   Auto Motor Iden (identification) is enabled only for ball screw linear stages. Auto Motor Iden remotely identifies the motor, and then populates the model field with the appropriate motor information. Direct drive linear stages do not interact with Auto Motor Iden, and the model field data must be manually selected for the appropriate motor information to load.
6. From the Displayed Units pull-down menu, choose User.

   This programs Ultraware software to make distance moves in User Units (mm or in.).

7. In the Motor Encoder Units pull-down menu, enter the appropriate values from the tables on page 59.

Velocity, position, and acceleration counts per unit are based on the selected User Units (mm or in.).

User Unit Scaling Parameters (1)	**Distance Units for Ball Screw Linear Stages**	
	Metric	**English**
	MPAS-*xxxxxx*-V20*xxx*	MPAS-*xxxxxx*-V20*xxx*
Velocity Label	mm/s	in./s
Velocity Scale	6553.6	166461.44
Position Label	mm	in.
Position Scale	6553.6	166461.44
Acceleration Label	mm/s/s	in./s/s
Acceleration Scale	6553.6	166461.44

(1) User units are determined by the screw lead of the linear stage. The screw lead is defined in linear units of travel per revolution. For example, the travel per revolution of an MPAS-xxxxxx-V20xxx is 20 mm/rev. MP-Series Integrated Linear Stages with a ball screw use a feedback device that provides 128 sin/cos cycles per revolution of the motor. The Ultra3000 drive interpolates this signal by an additional 1024, causing the maximum count per internal motor revolution of the linear stage to be 131,072 counts/rev.

Table 4 - Direct Drive Linear Stage Distance Unit Settings

User Unit Scaling Parameters	**Distance Units**	
	Metric	**English**
Velocity Label	mm/s	in./s
Velocity Scale	200	5080
Position Label	mm	in.
Position Scale	200	5080
Acceleration Label	mm/s/s	in./s/s
Acceleration Scale	200	5080

Set Travel Limits

MP-Series Integrated Linear Stages are designed to use the software overtravel limits available in RSLogix 5000 and Ultraware software.

IMPORTANT Travel Limits apply to direct drive and ball screw linear stages.

Set Overtravel limits according to the maximum speed of the servo drive system and the payload of the application. You can determine the Deceleration Distance between the slide and the end-of-travel bumpers based on the combination of the Deceleration Rate of the load, and the available peak force from the stage-drive. Then use Motion Analyzer software to calculate the minimum deceleration distance at the maximum speed of your application. (1)

In addition to software overtravel limits, the end of travel bumpers for the linear stage will stop the carriage up to the ratings listed in the table.

Table 5 - Bumper Stop Energy Limits for Linear Stage End of Travel

Cat No.	Energy Limit
MPAS-*x6xxxx*-V20*xxx*	37.3 J (330 in•lb)
MPAS-*x6xxxx*-ALM*x2x*	

Cat No.	Energy Limit
MPAS-*x8xxxx*-V20*xxx*	22.7 J (201 in•lb)
MPAS-*x8xxxx*-ALM*x2x*	45.5 J (403 in•lb)

Cat No.	Energy Limit
MPAS-*x9xxxx*-V20*xxx*	16.5 J (146 in•lb)
MPAS-*x9xxxx*-ALM*x2x*	35.2 J (312 in•lb)

ATTENTION: If energy greater than the bumper capacity is anticipated in the application, you must provide additional mechanical means for safely stopping the carriage.

To calculate kinetic energy of the carriage with your payload use the formula

$$\left(J = \frac{1}{2} \times M \times V^2\right)$$

J = energy in Joules
M = moving mass (linear carriage + payload) [kg]
V = maximum velocity of stage in your application [m/s] (1)

Program Home to Torque for Kinetix Multi-axis Drives with Linear Stages

If you are using a Kinetix 2000 or Kinetix 6000 drive, you will find it useful to read and apply About Home to Torque-level Homing on page 116 to your system-level program.

IMPORTANT Home to Torque Programming should be performed only after you have tuned your drive and linear stage combination.

You should have successfully completed tuning by performing the steps in the table on page 53.

This appendix provides information on using torque-level homing to reference a known (home) position by monitoring torque while driving an axis into a mechanical hard-stop.

(1) Velocity and kinetic energy can be much higher due to uncontrolled, worst-case motion that is only constrained by the length of stroke and the power capacity of the motor-drive pairing.

Maintenance

Introduction

This chapter describes the maintenance procedures for your linear stage.

Topic	Page
Before You Begin	61
Recommended Maintenance Intervals	61
Lubricate the Bearing	62
Clean the Strip Seal	63
Clean the Cover	63

IMPORTANT Any person that teaches, operates, maintains, or repairs these linear stages must be trained and demonstrate the competence to safely perform the assigned task.

Before You Begin

You will need the following tools to lubricate and clean your linear stage:

ATTENTION: Lockout and tagout input power before servicing.

- 0.36 m (14 in.) or larger clamp with soft jaws
- Grease pump kit (catalog number MPAS-GPUMP) with tip type installed and primed
- Grease cartridge (catalog number MPAS-CART), included in grease pump kit.
- Air line with a maximum pressure of 68 kpa (10 psi).
- Lint free cloth
- Isopropyl alcohol, as necessary for cleaning

Recommended Maintenance Intervals

Recommended maintenance and lubrication intervals are:

- direct drive linear stages every 6 months or 2500 km (1550 mi) of travel, whichever comes first
- ball screw linear stages every 6 months or 150,000,000 revolutions, whichever comes first

Lubricate the Bearing

Lubricate the linear stage bearings as shown and described below. Use the MP-Series Integrated Linear Stage grease pump kit, and additional grease cartridges as necessary.

Figure 11 - Direct Drive Linear Stage Lubrication

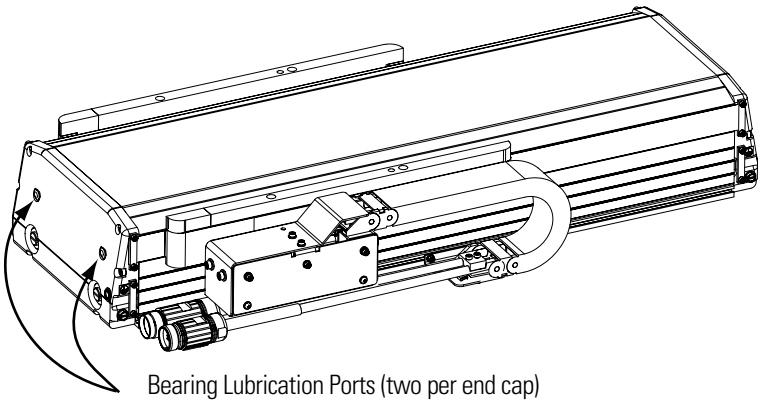
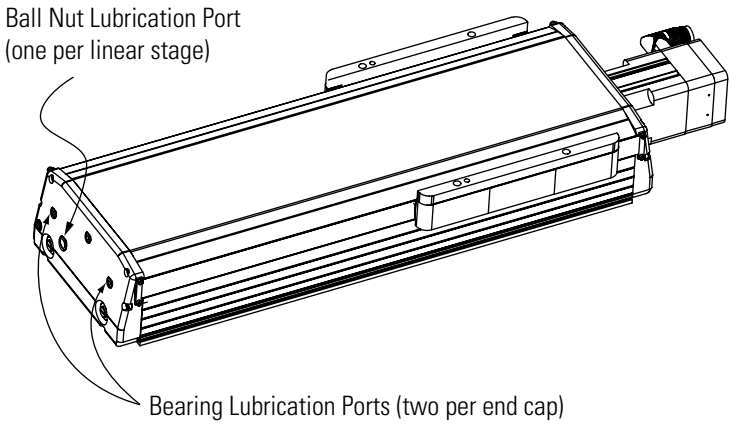


Figure 12 - Ball Screw Linear Stage Lubrication



1. Position the carriage at end of travel and clamp it to hold the linear stage against end block.

ATTENTION: Do not use clamp across the side panels. This will deform and damage the side panels.

2. Remove the lubrication port protective caps on each end cap.
3. Insert the tip of the grease pump into the lubrication port, pushing in until firm contact with the grease fitting is made.
4. Pump the handle until back pressure is felt, or a maximum of two strokes are made.

5. Repeat step 3 and step 4 to the other lubrication ports.
6. Move the carriage to opposite end of travel and repeat steps 1...5.
7. Remove the clamp.
8. Reinstall the protective caps on all the lubrication ports.

Clean the Strip Seal

Clean the strip seals, if installed, using a lint free cloth lightly saturated with isopropyl alcohol.

IMPORTANT	Replace the strip seal if it cannot be cleaned, or if an uneven or scored surface is detected during cleaning. A buildup of foreign material on the strip seal degrades the performance of the linear stage. This buildup coupled with rapid movement of the carrier and the resulting friction will score the surface and create a burnished appearance on the strip seal. Elements that contribute to a typical buildup on the strip seals are dust, grease, and other contaminants normally encountered in any operating environment that is not strictly controlled.

Refer to the Remove the Strip Seal on page 69 and Replace the Strip Seal on page 71 when performing this task.

Clean the Cover

Clean the covers at the same time you clean the strip seals. Use pressurized air and a lint free cloth lightly saturated with isopropyl alcohol to remove any dirt or grease.

Notes:

Removing and Replacing Multi-axis Stage Components

Introduction

This chapter provides procedures for user-replaceable parts on the multi-axis stage. Procedures for the cover, and the rotary motor replacement are limited to the secondary stage. Return your multi-axis stage to factory for the cover and the rotary motor replacement for the base stage.

Topic	Page
Before You Begin	66
Cable Carrier Assembly Removal Procedures	66
Cable Carrier Assembly Installation	69
Remove the Strip Seal	69
Remove the Cover	70
Install the Cover	70
Replace the Strip Seal	71
Install the Side Cover	72
Replace the Rotary Motor	73

ATTENTION: Lock out and tag out input power before servicing.

These procedures are not applicable to both types of linear stages. Direct drive and ball screw linear stages have unique configurations.

Before You Begin

Assemble these tools before you begin removal and replacement procedures.

- Torque wrench
- 2.5 mm, 3 mm, 4 mm, 5 mm, and 6mm L-shaped hex keys
- 0.8 mm (0.030 in.) shim
- Tin snips
- Loctite 222
- Phillips and flat-blade screwdrivers
- Ruler
- Pencil or marker

Cable Carrier Assembly Removal Procedures

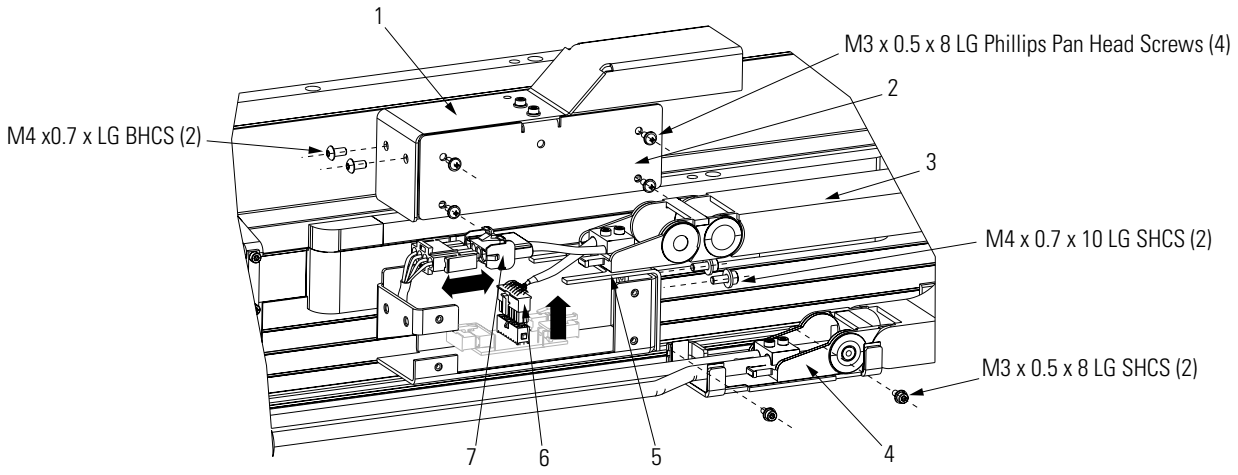
There are three different cable carrier removal procedures. They differ by the types of linear stage used on the base and secondary axis. Please be sure to follow the procedure appropriate for your multi-axis stage. The Cable Carrier Replacement diagram shows components common to all procedures.

WARNING: Remove power from drive and disconnect extension cables before performing this procedure. Failure to remove power could result in personal injury and equipment damage.

Never pull on wires when disconnecting power and feedback connectors. Pulling on wires could result in damage to circuit continuity.

Figure 13 - Cable Carrier Replacement

A single linear stage shown for clarity.



Item	Description
1	Junction Box Cover
2	Junction Box Side Cover
3	Cable Carrier Module
4	End Bracket

Item	Description
5	Angle Bracket
6	Feedback Connector
7	Motor Power Connector

Remove the Cable Carrier Assembly

For MPMA-xxDxxxxxx-SxC and MPMA-xxExxxxxx-SxC Multi-axis Stages

Follow this procedure is to remove the cable carrier assembly from multi-axis stage with a direct drive base axis and ballscrew secondary axis.

TIP Mark the location of the end brackets before removing the cable carrier, this will make it easier to align it when reinstalling.

1. Remove and save for re-installation all P-clamps and hardware used to route cables from upper axis to lower axis.
2. Disconnect the motor power connector from the upper axis motor.
3. Disconnect the feedback connector from the upper axis motor.
4. Remove the three SHCS from junction box side cover of the lower stage that mount the outer cable carrier bracket.
5. Lay the outer cable carrier out flat.
6. Remove the two pan head phillips screws from junction box side cover.
7. Remove the two button head cap screws (BHCS) from the junction box cover.
8. Remove the junction box cover assembly.
9. Separate the motor power connector by squeezing the side tabs and pulling on the housing. Do not pull on the wires.
10. Separate the feedback connector from the circuit board by pushing on the center tab and pulling on the connector housing. Do not pull on the wires.
11. Remove the two SHCS from the cable carrier angle bracket.
12. Lay the cable carrier out flat and mark the location of the end bracket.

TIP Avoid separation of SHCS from square nut in T-slot. Leaving them attached will make assembly easier.

13. Loosen, but do not remove, the two SHCS that secure the end bracket to the base of the lower stage.
14. Slide the screws out of the bracket slots and remove the cable carrier.

For MPMA-xxIxxxxxx-SxC, MPMA-xxPxxxxxx-SxC, and MPMA-xxQxxxxxx-SxC Multi-axis Stages

Follow this procedure to remove the cable carrier assembly for a multi-axis stage with a ballscrew base and ballscrew secondary axis.

TIP Mark the location of the end brackets before removing the cable carrier, this will make it easier to align it when reinstalling.

1. Remove and save for re-installation any P-clamps and hardware used to route cables from upper axis to lower axis.
2. Disconnect the motor power connector from the upper axis motor.
3. Disconnect the feedback connector from the upper axis motor.
4. Remove the two socket head cap screws (SHCS) that attach the cable carrier angle bracket to the underside of the lower carriage.
5. Lay the cable carrier out flat and mark the location of the end bracket.

   TIP Avoid separation of SHCS from square nut in T-slot. Leaving them attached will make assembly easier.

6. Loosen, but do not remove, the two SHCS securing the end bracket to the base of the lower stage.
7. Slide the screws out of the bracket slots and remove the cable carrier.

For MPMA-xxBxxxxxx-SxC and MPMA-xxCxxxxxx-SxC Multi-axis Stages

Follow this procedure to remove the cable carrier assembly from a multi-axis stage with a direct driver base and direct drive secondary axis.

TIP Mark the location of the end brackets before removing the cable carrier, this will make it easier to align it when reinstalling.

1. Remove and retain for re-installation any P-clamps and hardware used to route cables from upper axis to lower axis.
2. Remove the four pan head phillips screws from junction box side cover of the upper stage.
3. Remove the two button head cap screws (BHCS) from the junction box cover.
4. Remove the junction box cover assembly.
5. Separate the motor power connector by squeezing the side tabs and pulling on the housing. Do not pull on the wires.
6. Separate the feedback connector from the circuit board by squeezing the center tab releasing lock and pulling on the connector housing. Do not pull on the wires.
7. Remove the two socket head cap screws (SHCS) from the cable carrier angle bracket.
8. Lay the cable carrier out flat and mark the location of the end bracket.

   TIP Avoid separation of SHCS from square nut in T-slot. Leaving them attached will make assembly easier.

9. Loosen, but do not remove, the two SHCS securing the end bracket to the base of the upper stage.

10. Slide the screws out of the bracket slots and lay carrier parallel to lower stage.
11. Repeat step 3 through 10 for the base stage.

Cable Carrier Assembly Installation

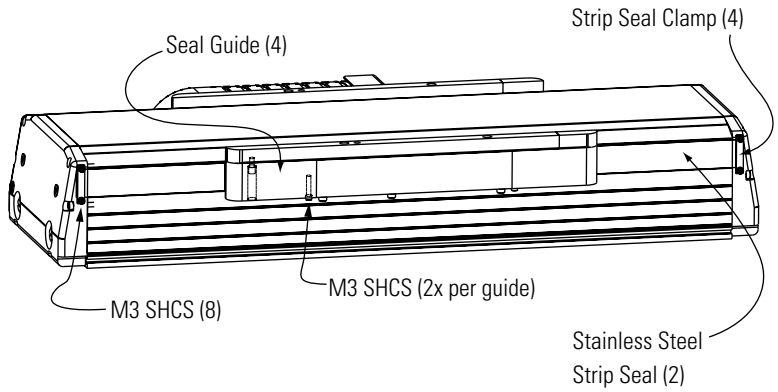
Follow the Cable Carrier Assembly Removal procedure for your multi-axis stage in reverse adding the following steps when needed:

- Align the cable carrier using the alignment marks made when the worn cable carrier was removed.
- Use Loctite 222 on all hardware during installation.

Remove the Strip Seal

Follow these directions to remove a strip seal.

Figure 14 - Linear Stage Seal Components



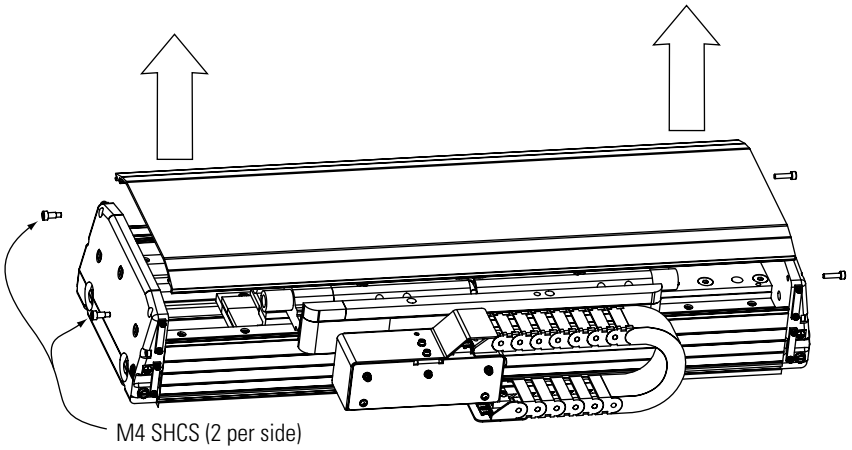
IMPORTANT Handle strip seal material with care. The strip seal has sharp edges that can cut if mishandled.

1. Loosen the strip seal clamps at each end of the linear stage.
2. Carefully grasp the end of the strip seal and slide it out of the linear stage.

Remove the Cover

Follow these directions to remove a secondary stage cover.

1. Remove strip seals following the strip seal removal procedure.
2. Remove the four M4 screws securing the linear stage cover to the end caps.
3. Remove the cover.



Install the Cover

Follow these directions to install a secondary stage cover.

1. Start at the end cap nearest the magnetic cautionary label or the MP motor, and install two M4 x 25 SHCS.
2. Torque the M4 x 25 SCHS to 4 N•m (35 lb•in).
3. Make sure the cover contacts the end cap.
4. On the opposite end install two M4 x 30 SHCS and bottom out the screw.

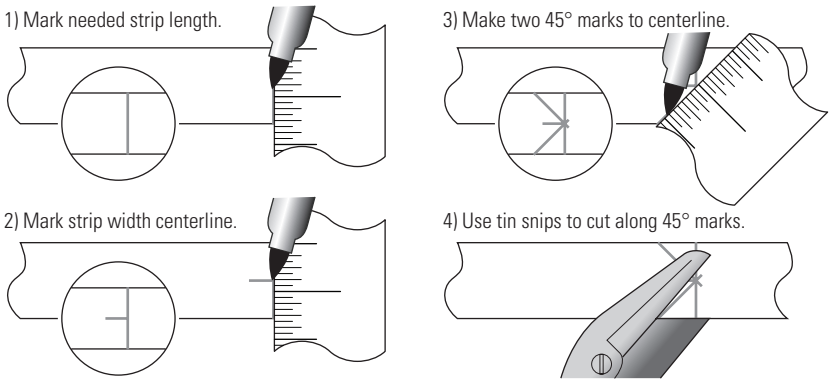
   The cover will not contact the end cap on this side and will float on the screw.

Replace the Strip Seal

Follow these directions to replace the strip seals.

ATTENTION: Handle strip seal material with care. The strip seal has sharp edges that can cause personal injury if mishandled.

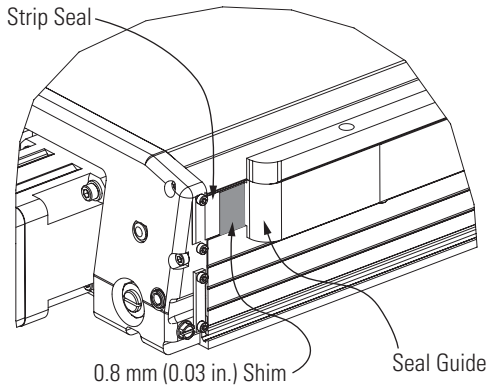
1. Remove power from the linear stage, and lock out and tag the power source.
2. Follow the instructions below on how to measure, mark, and cut new strip seals.



3. Position the carriage at the midpoint of stage travel.
4. Expose the center metal section of the carriage's seal strip guide by loosening the screws securing the end clamps and those at the carriage seal guide.
5. Thread the new strip seal, point end first, through the seal guides, the carriage, and then the end clamps.
6. Center and smooth the strip seal against the top cover and the side panel magnetic strips.
7. Using very light pressure, hold the seal guide against the strip seal, and then tighten the seal guide.
8. Tighten one end clamp, but do not tighten the clamp on the other end.
9. Move the carriage by hand through the complete range of travel and make sure the strip seal seats smoothly against the cover and side panel magnet strips.

   Pulling against the tightened end clamp will help to smooth the seal.
10. Once the seal lays flat and smooth against the top cover and side panel, tighten the second end clamp.
11. With the outside edge of the end clamps as a guide, use tin snips to cut and remove excess strip seal material.
12. Position the carriage at the far ends of travel.

13. Adjust the seal guide by inserting a 0.8 mm (0.030 in.) shim between the seal guide and the strip seal.



14. Return the linear stage to service.

Install the Side Cover

Follow these directions to install a side cover.

1. Insert a side cover into the base of the linear stage by holding it with the top slightly tilted outward and hooking the bottom of the side cover in the channel near the bottom of the base.

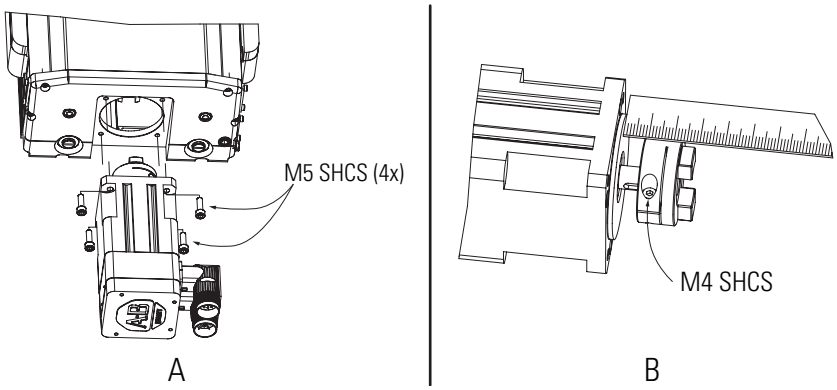
   TIP If installing the side cover with strip seals in place use a flat-blade screwdriver to lift the side cover by inserting the screwdriver under the cover between the cover and the base.

2. Starting at the end cap adjacent to the ground screw, install one M4 SHCS and torque it to 4 N•m (35 lb•in).
3. On the opposite end install one M3 SHCS and torque it to 2.5 N•m (20 lb•in).

Replace the Rotary Motor

Follow these directions to replace a secondary stage rotary motor.

1. Disconnect the motor cables.
2. Remove the four M5 SHCS and lock washers that secure the motor to the linear stage.

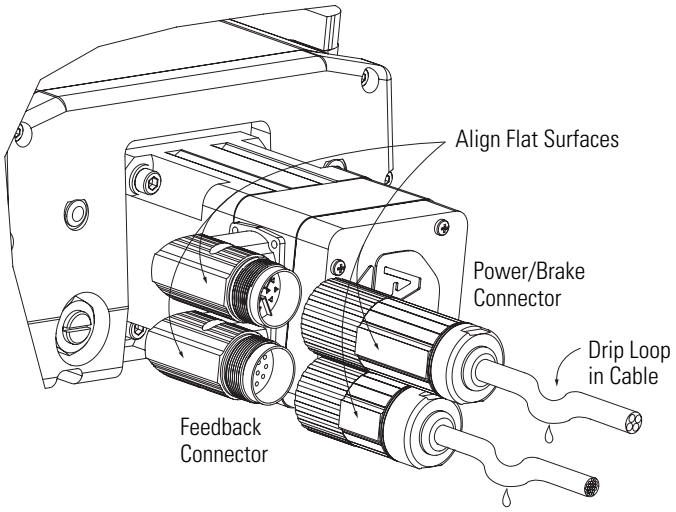


3. Remove the motor.

IMPORTANT	Measure the position of the coupling on the motor shaft as shown in panel B of the diagram above.

4. Mark the measured coupling position on the new motor shaft.
5. Loosen the M4 SHCS in the coupling and remove the coupling from old motor shaft.
6. Position the coupling on the new motor shaft, align it with the mark made in step 4, and then tighten the coupling.
7. Align the coupling halves and install the motor.
8. Secure the motor with four M5 SHCS and lock washers.
9. Torque each cap screw to 4 N•m (35 lb•in) using a diagonal tightening sequence.

10. Attach the power and feedback cables to the motor, by aligning the flat edges on the cable connector with that on the motor connector.



Troubleshooting

Introduction

This chapter is divided into three sections. The first section provides diagnostic tables to use only during axis commissioning. Use the operational section to troubleshoot either a direct drive or ball screw linear stage after the axis is up and running, and use the thermistor measurement section only when direct drive operational troubleshooting suggests it.

Refer to the following publications when troubleshooting a a linear stage connected to one of the following drives:

- Kinetix 2000 Multi-axis Servo Drive User Manual, publication 2093-UM001
- Kinetix 6000 Multi-axis Servo Drive User Manual, publication 2094-UM001
- Ultra3000 Digital Servo Drives Installation Manual, publication 2098-IN003
- Ultra3000 Digital Servo Drives Integration Manual, publication 2098-IN005

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Troubleshooting During Commission and Startup	76
Operational Troubleshooting	76

Troubleshooting During Commission and Startup

Use this section to diagnose and correct troubles encountered while using RSLogix 5000 software to commission and startup your linear stage.

Description	Possible Cause	Corrective Action
Initialization stops at SERCOS Level 3 and Logix software reports Motor Attribute Error.	Incorrect motor catalog number.	Enter correct motor catalog number.
	Incorrect drive firmware.	For Kinetix 6000 and Kinetix 2000 drives, verify the firmware revision is 1.96 or later, For a Ultra3000 drive, verify the firmware revision is 1.52 or later.
	Using a previously defined axis.	Delete and recreate the axis.
Drive reports error E04, E11, or E07.	Incorrect feedback wiring.	Verify feedback wiring. Refer to pages 112…114.

In the Hookup tab of Axis Properties, click on the Test Command and Feedback button to verify wiring and commissioning of your linear stage. The following table lists possible solutions for problems encountered while performing this test:

TIP Hookup test may fail if friction and weight forces exceed 20% of the stage's continuous force rating.

Description	Possible Cause	Corrective Action
Linear stage, direct drive or ball screw, passes Hookup test but the carriage jumps position when the axis is enabled.	Wiring of the Hall signals with relation to the motor's power wiring is incorrect.	Verify wiring of Hall signals (S1, S2, and S3) and power wires (U, V, and W).
Direct drive linear stage fails Hookup test, but wiring is known to be correct.	Incorrect drive firmware.	Verify the Kinetix 6000 drive or, Kinetix 2000 drive has revision 1.96 or later firmware. Verify you are using revision 16.00 or later of Logix software.

Operational Troubleshooting

Use this section to diagnose and correct troubles with a direct drive or ball screw driven linear stage after it has been commissioned. Read the entire section to understand the kinds of troubles you may encounter and the possible fixes.

The evaluation procedures for direct drive and ball screw linear stages will help you determine if faulty stage operation indicates a need to lubricate the stage or a more fundamental problem. To interpret error codes reported by the drive, refer to the Troubleshooting Procedures for Ball Screw Linear Stages table on page 79, or the drive manuals referenced on page 75.

Evaluate the Direct Drive Linear Stage

1. Power down the drive system.
2. Disconnect the drive from the linear stage.

ATTENTION: Lockout and tagout input power before servicing the linear stage.

3. By hand move the carriage through the entire range of motion. It should move free and smooth.
4. If excessive resistance is felt, clean and relubricate the linear bearings.
5. Perform the procedures for a direct drive linear stage listed in the troubleshooting tables on page 78.
6. If the problem persists, return for factory evaluation and possible repair.

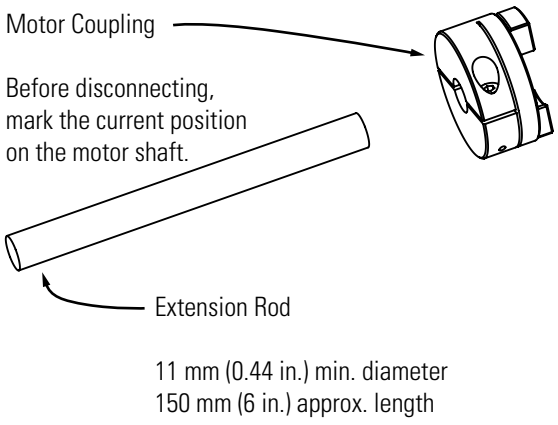
Evaluate the Ball Screw Linear Stage

1. Power down the drive system.
2. Disconnect the drive from the linear stage.

ATTENTION: Lockout and tagout input power before servicing the linear stage.

3. Remove the rotary motor.
4. By hand move the carriage through the entire range of motion. It should move free and smooth.

TIP To make it easier to move a fine pitch stage, connect an 11 mm (0.44 mm) extension rod to the motor coupling. Move the stage by turning the extension with a hand wrench.



5. If excessive resistance is felt, clean and relubricate the linear bearings.
6. Perform the procedures for a ball screw linear stage listed in the troubleshooting tables on page 78 and page 79.

If the problem persists, return for factory evaluation and possible repair.

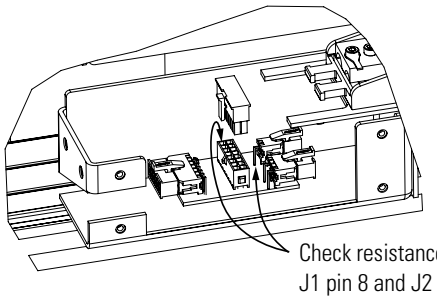
Table 6 - Troubleshooting Procedures for Direct Drive or Ball Screw Linear Stages

ATTENTION: Lockout and tagout input power before servicing the linear stage.

Description	Possible Cause	Corrective Action
Kinetix 6000 drive or Kinetix 2000 drive reporting error E19. Ultra3000 drive reporting error E19, E22, or E23.	For sealed stages excess friction can be caused by contamination on the strip seal.	Clean the strip seal with a clean, soft cloth wetted with isopropyl alcohol. If problem persists, replace strip seal. Refer to Remove the Strip Seal on page 69 and Replace the Strip Seal on page 71.
	Stage received a large impact. The ball screw or linear bearings have become misaligned or there is damage to the rails.	Return stage to factory for evaluation and repair.
	Linear bearing has excess friction.	Refer to Evaluate the Direct Drive Linear Stage on page 77 or Evaluate the Ball Screw Linear Stage on page 77.

Table 7 - Troubleshooting Procedures for Direct Drive Linear Stages

ATTENTION: Lockout and tagout input power before servicing the linear stage.

Description	Possible Cause	Corrective Action
Intermittent reporting of error E11, E07, or E20 by the drive.	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module; refer to page 66 for replacement instructions.
Intermittent reporting of error E04 by the drive.	Ambient temperature of the stage exceeds 40 °C (104 °F).	Increase ventilation.
	Thermistor circuit is defective.	Disconnect the flex cable and probe the open Junction Box. At room temperature 25 °C (77 °F), verify the resistance of the circuit is 100…200 Ohms. If not in range, return for factory service.  Check resistance between J1 pin 8 and J2 pin 2 Refer to page 101 for thermistor resistance values at other temperature ranges.
	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module; refer to page 66 for replacement instructions.

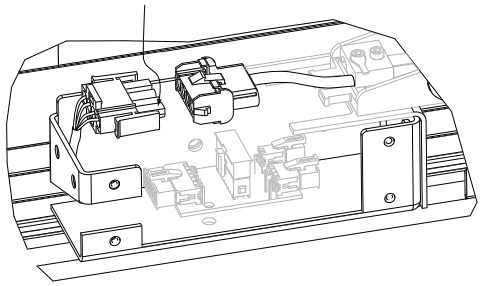
Description	Possible Cause	Corrective Action
Drive reporting error E07 or E20.	Environment is electrically noisy and cable shield is compromised.	Verify carrier cable module and extension cable shield termination are secure.
Drive reporting error E05.	Defective motor	Disconnect the flex cable and probe the Motor Power connector (white Mate-N-Lok) in the open Junction Box. 1. Measure the resistance between pins 1 and 2, pins 2 and 3, and pins 1 and 3, and evaluate the measurements with the following criteria: – The resistance values will vary depending on the MPAS model, but must be less than 15 Ohms. – The difference between the three resistance measurements must be less than 1 Ohm. 2. There should be an open circuit between pins 1, 2, 3, and pin 4 (GND). If any measurement is not in range, return for factory service. Motor Power Connector Pin 1 
	Cable carrier module exceeds its useful life of 10,000,000 cycles and is starting to fail.	Replace cable carrier module; refer to page 66 for replacement instructions.

Table 8 - Troubleshooting Procedures for Ball Screw Linear Stages

ATTENTION: Lockout and tagout input power before servicing the linear stage.

Description	Possible Cause	Corrective Action
Carriage is not moving but the controls report axis motion.	Rotary motor coupling broken or slipping.	Remove rotary motor and verify integrity of coupling.
Excessive carriage play.	Motor coupling set screw is loose.	Tighten motor coupling set screw.
	Ball screw end blocks have excessive wear.	Return stage to factory for service.
Drive reporting error E05.	Motor is damaged.	Check that the phase-to-phase resistance of each motor phase. The resistance should be equal, and not shorted to ground or to the shield.
Kinetix 6000 drive or Kinetix 2000 drive reporting error E19. Ultra3000 drive reporting error E19, E22, or E23.	Brake on the motor does not release.	Manually release brake, and check that motor shaft is free to turn and the bearing feels smooth.

Notes:

Specifications and Dimensions

This appendix is a supplement to this document. Associated Kinetix publications listed in Additional Resources on page 7 and information in product specifications may supersede the information in this appendix.

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MPMA-xABxxxxxx-xxx Product Specifications and Dimensions	82
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Brake Specifications for Ball Screw Linear Stage Motors	101
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MPMA-*x*AB*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Y stages with 250 mm frame linear motor driven X-axis and 200 mm frame linear motor driven Y-axis. Maximum payload is 15 kg (33.1 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 9 - MPMA-*x*AB*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*ABC0C0A0-S1C	200 (7.9)		N/A	5 micron resolution incremental magnetic linear encoder (direct drive only)		N/A	15	15	N/A	56.4 (124.1)
MPMA-*x*ABC6C6A0-S1C	260 (10.2)									59.2 (130.2)
MPMA-*x*ABD2D2A0-S1C	320 (12.6)									62.1 (136.6)
MPMA-*x*ABD8D8A0-S1C	380 (15.0)									64.4 (141.7)
MPMA-*x*ABE4E4A0-S1C	440 (17.3)									67.3 (148.1)
MPMA-*x*ABF6F6A0-S1C	560 (22.0)									73.1 (160.8)

Table 10 - Allowable Payload Based Upon X-axis Acceleration and Y-axis Travel

X-axis Acceleration (1) g	Y-axis Travel mm (in.)					
	200	260	320	380	440	560
1.4	0.5	—	—	—	—	—
1.3	3.6	2.4	1.0	0.2	—	—
1.2	7.2	6.0	4.6	3.8	2.4	0.1
1.1	11.4	10.2	8.8	8.0	6.6	4.3
1.0	16.5	15.3	13.9	13.1	11.7	9.4
0.9	22.7	21.5	20.1	19.3	17.9	15.6

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded.

Table 11 - MPMA-*x*AB*xxxxxx-xxx* Product Dimensions

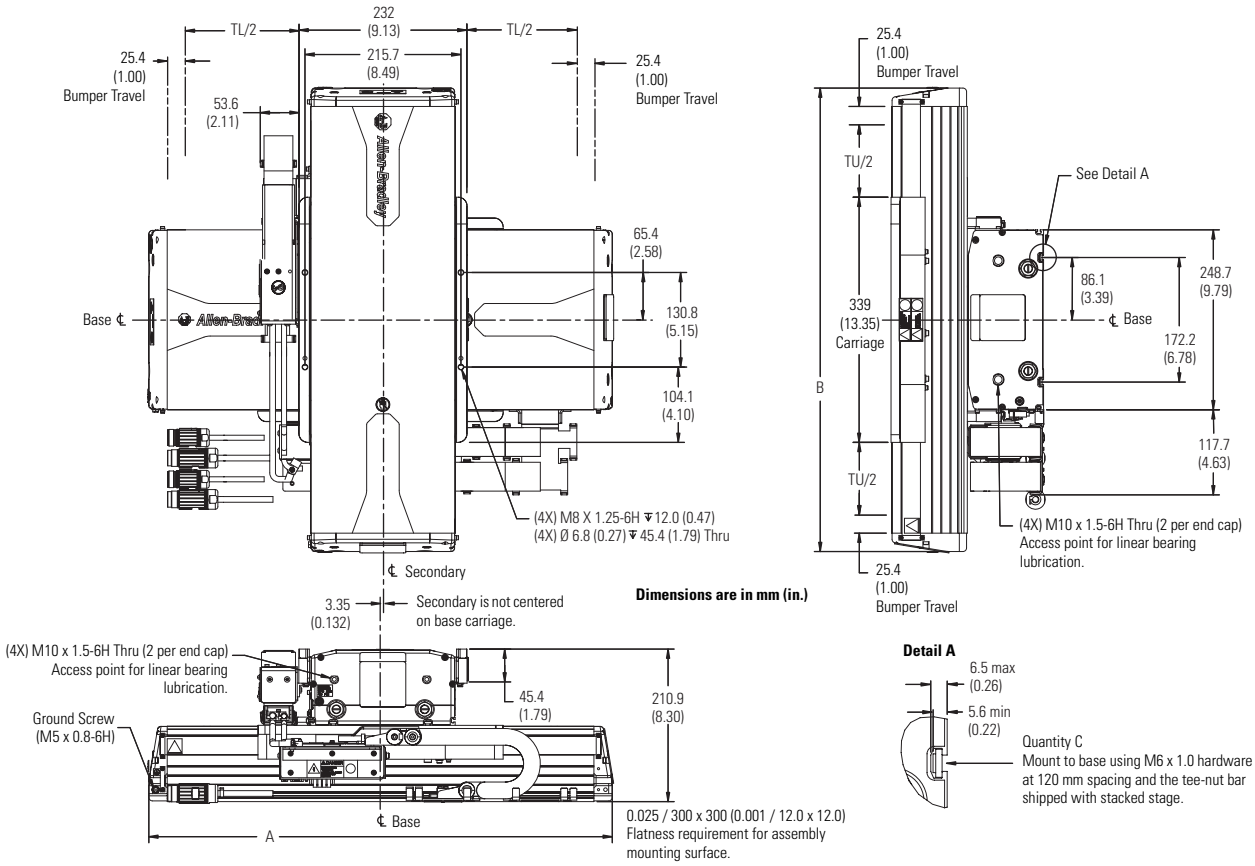


Table 12 - MPMA-*x*AB*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Y-axis)	TU Travel (Y-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-AABC0C0A0-S1C	641 (25.2)	200 (7.9)	641 (25.2)	200 (7.9)	10
MPMA-AABC6C6A0-S1C	701 (27.6)	260 (10.2)	701 (27.6)	260 (10.2)	12
MPMA-AABD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	
MPMA-AABD8D8A0-S1C	821 (32.3)	380 (15.0)	821 (32.3)	380 (15.0)	14
MPMA-AABE4E4A0-S1C	881 (34.7)	440 (17.3)	881 (34.7)	440 (17.3)	
MPMA-AABF6F6A0-S1C	1001 (39.4)	560 (22.0)	1001 (39.4)	560 (22.0)	16
MPMA-BABC0C0A0-S1C	641 (25.2)	200 (7.9)	641 (25.2)	200 (7.9)	10
MPMA-BABC6C6A0-S1C	701 (27.6)	260 (10.2)	701 (27.6)	260 (10.2)	12
MPMA-BABD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	
MPMA-BABD8D8A0-S1C	821 (32.3)	380 (15.0)	821 (32.3)	380 (15.0)	14
MPMA-BABE4E4A0-S1C	881 (34.7)	440 (17.3)	881 (34.7)	440 (17.3)	
MPMA-BABF6F6A0-S1C	1001 (39.4)	560 (22.0)	1001 (39.4)	560 (22.0)	16

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*AC*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Y stages with 250 mm frame linear motor driven X-axis and 250 mm frame linear motor driven Y-axis. Maximum payload is 20 kg (44.0 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 13 - MPMA-*x*AC*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*ACB4B4A0-S1C	140 (5.5)		N/A	5 micron resolution incremental magnetic linear encoder (direct drive only)		N/A	15	15	N/A	62.2 (136.8)
MPMA-*x*ACC0C0A0-S1C	200 (7.9)									66.0 (145.2)
MPMA-*x*ACC6C6A0-S1C	260 (10.2)									69.2 (152.2)
MPMA-*x*ACD2D2A0-S1C	320 (12.6)									72.2 (158.8)

Table 14 - Allowable Payload Based Upon X-axis Acceleration and Y-axis Travel

X-axis Acceleration (1) g	Y-axis Travel mm (in.)			
	140	200	260	320
1.3	1.1	—	—	—
1.2	4.6	2.7	1.1	—
1.1	8.9	7.0	5.4	3.9
1.0	13.9	12.0	10.4	8.9
0.9	20.1	18.2	16.6	15.1

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded.

Table 15 - MPMA-*x*AC*xxxxxx-xxx* Product Dimensions

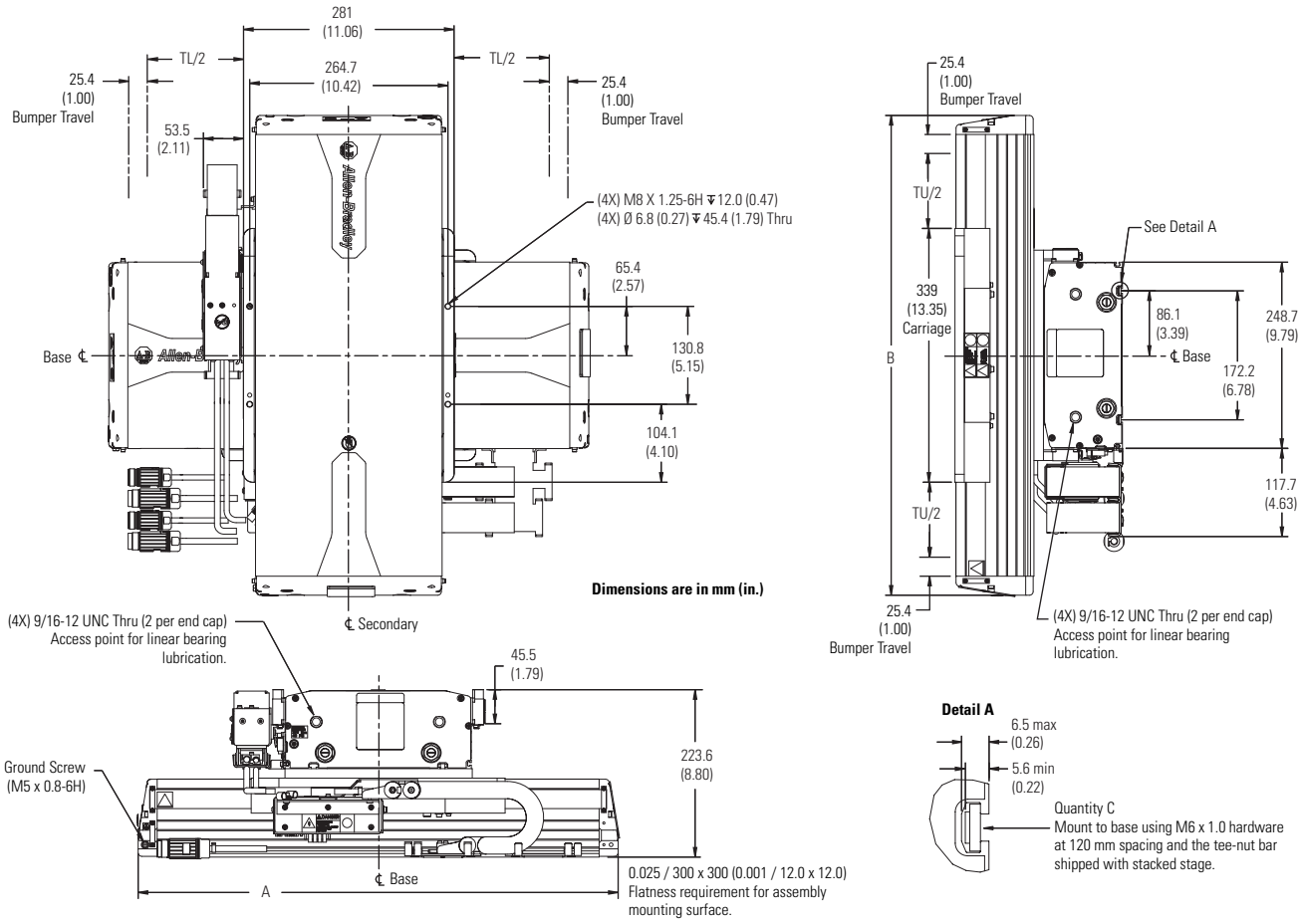


Table 16 - MPMA-*x*AC*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Y-axis)	TU Travel (Y-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-AACB4B4A0-S1C	581 (22.9)	140 (5.5)	581 (22.9)	140 (5.5)	10
MPMA-AACC0C0A0-S1C	641 (25.2)	200 (7.9)	641 (25.2)	200 (7.9)	
MPMA-AACC6C6A0-S1C	701 (27.6)	260 (10.2)	701 (27.6)	260 (10.2)	12
MPMA-AACD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	
MPMA-BACB4B4A0-S1C	581 (22.9)	140 (5.5)	581 (22.9)	140 (5.5)	10
MPMA-BACC0C0A0-S1C	641 (25.2)	200 (7.9)	641 (25.2)	200 (7.9)	
MPMA-BACC6C6A0-S1C	701 (27.6)	260 (10.2)	701 (27.6)	260 (10.2)	12
MPMA-BACD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*AP*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Y stages with 200 mm frame ballscrew driven X-axis and 200 mm frame ballscrew driven Y-axis. Maximum payload is 20 kg (44.0 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 17 - MPMA-*x*AP*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*APB8B8A0-S1C	180 (7.1)		N/A	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)		N/A	60	60	N/A	36.1 (79.4)
MPMA-*x*APC4C4A0-S1C	240 (9.4)									37.9 (83.4)
MPMA-*x*APD0D0A0-S1C	300 (11.8)									39.9 (87.8)
MPMA-*x*APE2E2A0-S1C	420 (16.5)									43.9 (96.6)
MPMA-*x*APG6G6A0-S1C	660 (26.0)									51.5 (113.3)

Table 18 - Allowable Payload Based Upon X-axis Acceleration and Y-axis Travel

X-axis Acceleration (1) g	Y-axis Travel mm (in.)				
	180	240	300	420	660
4	9.4	8.4	7.4	5.4	1.4
3.8	10.5	9.5	8.5	6.5	2.5
3.6	11.8	10.8	9.8	7.8	3.8
3.4	13.2	12.2	11.2	9.2	5.2
3.2	14.8	13.8	12.8	10.8	6.8
3	16.6	15.6	14.6	12.6	8.6
2.8	18.7	17.7	16.7	14.7	10.7
2.6	21.1	20.1	19.1	17.1	13.1
2.4	23.8	22.8	21.8	19.8	15.8
2.2	27.1	26.1	25.1	23.1	19.1

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded. Do not exceed 1.1 m/s maximum velocity of ballscrew axis.

Table 19 - MPMA-*x*AP*xxxxxx*-*xxx* Product Dimensions

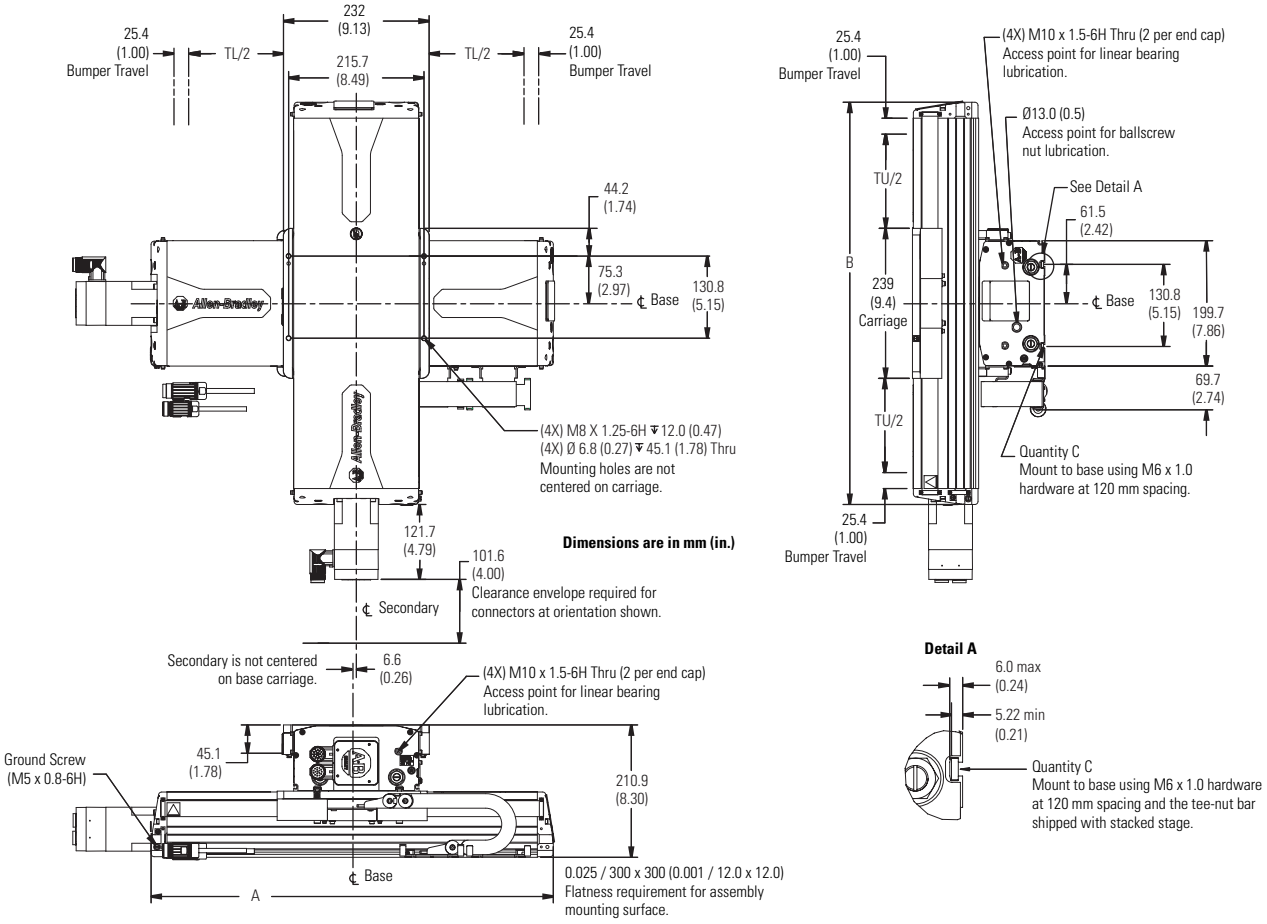


Table 20 - MPMA-*x*AP*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Y-axis)	TU Travel (Y-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-AAPB8B8A0-S1C	521 (20.5)	180 (7.1)	521 (20.5)	180 (7.1)	8
MPMA-AAPC4C4A0-S1C	581 (22.9)	240 (9.4)	581 (22.9)	240 (9.4)	10
MPMA-AAPD0D0A0-S1C	641 (25.2)	300 (11.8)	641 (25.2)	300 (11.8)	
MPMA-AAPE2E2A0-S1C	761 (30.0)	420 (16.5)	761 (30.0)	420 (16.5)	12
MPMA-AAPG6G6A0-S1C	1001 (39.4)	660 (26.0)	1001 (39.4)	660 (26.0)	16
MPMA-BAPB8B8A0-S1C	521 (20.5)	180 (7.1)	521 (20.5)	180 (7.1)	8
MPMA-BAPC4C4A0-S1C	581 (22.9)	240 (9.4)	581 (22.9)	240 (9.4)	10
MPMA-BAPD0D0A0-S1C	641 (25.2)	300 (11.8)	641 (25.2)	300 (11.8)	
MPMA-BAPE2E2A0-S1C	761 (30.0)	420 (16.5)	761 (30.0)	420 (16.5)	12
MPMA-BAPG6G6A0-S1C	1001 (39.4)	660 (26.0)	1001 (39.4)	660 (26.0)	16

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*CB*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Cartesian Stacked X/Y stages with 250 mm frame linear motor driven X-axis and 200 mm frame linear motor driven Y-axis. Maximum payload is 20 kg (44.0 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 21 - MPMA-*x*CB*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*CBD2D2A0-S1C	320 (12.6)	320 (12.6)	N/A	5 micron resolution incremental magnetic linear encoder (direct drive only)		N/A	15	15	N/A	69.7 (153.3)
MPMA-*x*CBE4D2A0-S1C	440 (17.3)									72.7 (159.9)
MPMA-*x*CBE4E4A0-S1C		440 (17.3)								74.9 (164.7)
MPMA-*x*CBF6E4A0-S1C	560 (22.0)									78.4 (172.4)
MPMA-*x*CBG8E4A0-S1C	680 (26.8)									81.4 (179.0)
MPMA-*x*CBG8F6A0-S1C		560 (22.0)								83.7 (184.1)
MPMA-*x*CBI0F6A0-S1C	800 (31.5)									87.2 (191.8)
MPMA-*x*CBJ2F6A0-S1C	920 (36.2)									90.3 (198.6)

Table 22 - Allowable Payload Based Upon X-axis Acceleration and Y-axis Travel

X-axis Acceleration (1) g	Y-axis Travel mm (in.)		
	320	440	560
1.1	4.1	1.9	—
1.0	9.1	6.9	4.6
0.9	15.3	13.1	10.8
0.8	23.0	20.8	18.5

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded.

Table 23 - MPMA-*x*CB*xxxxxx-xxx* Product Dimensions

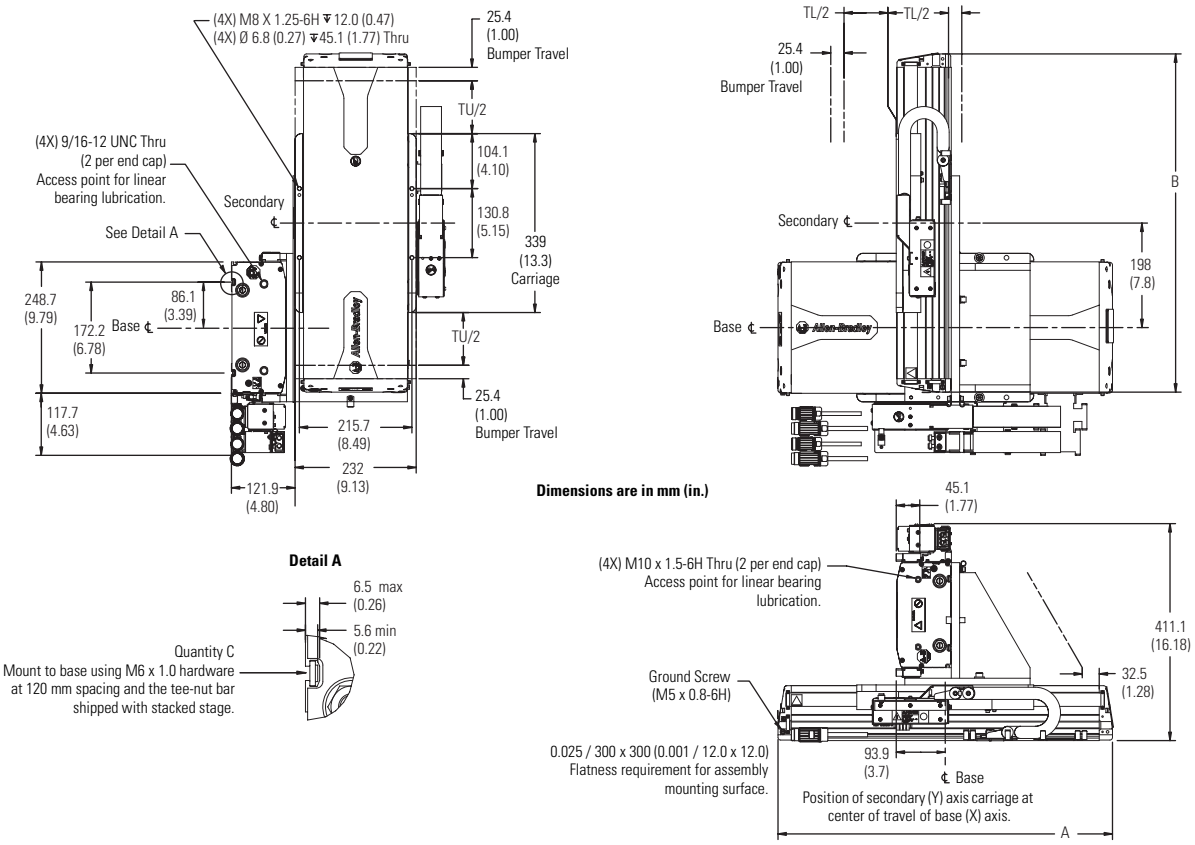


Table 24 - MPMA-*x*CB*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Y-axis)	TU Travel (Y-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-ACBD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	12
MPMA-ACBE4D2A0-S1C	881 (34.7)	440 (17.3)			14
MPMA-ACBE4E4A0-S1C			881 (34.7)	440 (17.3)	
MPMA-ACBF6E4A0-S1C	1001 (39.4)	560 (22.0)			16
MPMA-ACBG8E4A0-S1C	1121 (44.1)	680 (26.8)			18
MPMA-ACBG8F6A0-S1C			1001 (39.4)	560 (22.0)	
MPMA-ACBI0F6A0-S1C	1241 (48.9)	800 (31.5)			20
MPMA-ACBJ2F6A0-S1C	1361 (53.6)	920 (36.2)			22
MPMA-BCBD2D2A0-S1C	761 (30.0)	320 (12.6)	761 (30.0)	320 (12.6)	12
MPMA-BCBE4D2A0-S1C	881 (34.7)	440 (17.3)			14
MPMA-BCBE4E4A0-S1C			881 (34.7)	440 (17.3)	
MPMA-BCBF6E4A0-S1C	1001 (39.4)	560 (22.0)			16
MPMA-BCBG8E4A0-S1C	1121 (44.1)	680 (26.8)			18
MPMA-BCBG8F6A0-S1C			1001 (39.4)	560 (22.0)	
MPMA-BCBI0F6A0-S1C	1241 (48.9)	800 (31.5)			20
MPMA-BCBJ2F6A0-S1C	1361 (53.6)	920 (36.2)			22

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*CQ*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Cartesian Stacked X/Y stages with 250 mm frame ballscrew driven X-axis and 200 mm frame ballscrew driven Y-axis. Maximum payload is 25 kg (55.1 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 25 - MPMA-*x*CQ*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*CQD0D0A0-S1C	300 (11.8)	300 (11.8)	N/A	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)		N/A	60	60	N/A	51.7 (113.7)
MPMA-*x*CQE2D0A0-S1C	420 (16.5)									54.3 (119.4)
MPMA-*x*CQE2E2A0-S1C		420 (16.5)								56.3 (123.8)
MPMA-*x*CQG6E2A0-S1C	660 (26.0)									61.4 (135.0)
MPMA-*x*CQG6G6A0-S1C		660 (26.0)								65.2 (143.4)
MPMA-*x*CQH8G6A0-S1C	780 (30.7)									67.7 (148.9)
MPMA-*x*CQJ0G6A0-S1C	900 (35.4)									70.2 (154.4)

Table 26 - Allowable Payload Based Upon X-axis Acceleration and Y-axis Travel

X-axis Acceleration (1) g	Y-axis Travel mm (in.)		
	300	420	660
4	10.0	12.0	16.0
3.8	7.4	5.4	1.4
3.6	8.5	6.5	2.5
3.4	9.8	7.8	3.8
3.2	11.2	9.2	5.2
3	12.8	10.8	6.8
2.8	14.6	12.6	8.6
2.6	16.7	14.7	10.7
2.4	19.1	17.1	13.1
2.2	21.8	19.8	15.8
2	25.1	23.1	19.1

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded. Do not exceed 1.1 m/s maximum velocity of ballscrew axis.

Table 27 - MPMA-*x*CQ*xxxxxx-xxx* Product Dimensions

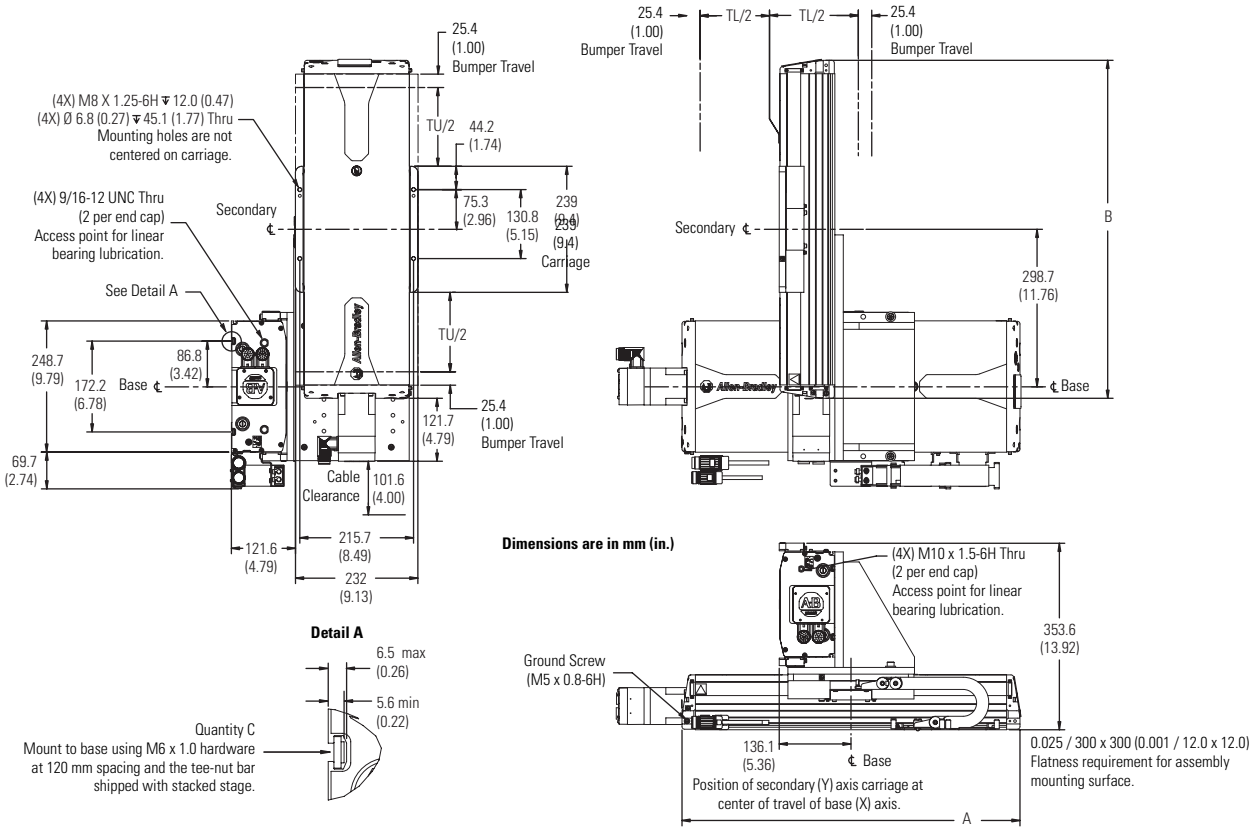


Table 28 - MPMA-*x*CQ*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Y-axis)	TU Travel (Y-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-ACQD0D0A0-S1C	641 (25.2)	300 (11.8)	641 (25.2)	300 (11.8)	10
MPMA-ACQE2D0A0-S1C	761 (30.0)	420 (16.5)			12
MPMA-ACQE2E2A0-S1C			761 (30.0)	420 (16.5)	
MPMA-ACQG6E2A0-S1C	1001 (39.4)	660 (26.0)			16
MPMA-ACQG6G6A0-S1C			1001 (39.4)	660 (26.0)	
MPMA-ACQH8G6A0-S1C	1121 (44.1)	780 (30.7)			18
MPMA-ACQJ0G6A0-S1C	1241 (48.9)	900 (35.4)			20
MPMA-BCQD0D0A0-S1C	641 (25.2)	300 (11.8)	641 (25.2)	300 (11.8)	10
MPMA-BCQE2D0A0-S1C	761 (30.0)	420 (16.5)			12
MPMA-BCQE2E2A0-S1C			761 (30.0)	420 (16.5)	
MPMA-BCQG6E2A0-S1C	1001 (39.4)	660 (26.0)			16
MPMA-BCQG6G6A0-S1C			1001 (39.4)	660 (26.0)	
MPMA-BCQH8G6A0-S1C	1121 (44.1)	780 (30.7)			18
MPMA-BCQJ0G6A0-S1C	1241 (48.9)	900 (35.4)			20

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*BE*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Z stages with 200 mm frame linear motor driven X-axis and 150 mm frame ballscrew driven Z-axis. Maximum payload is 20 kg (44.0 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 29 - MPMA-*x*BE*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*BED2A0B8-S2C	320 (12.6)	N/A	180 (7.1)	5 micron resolution incremental magnetic linear encoder (direct drive only)	N/A	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)	15	N/A	60	44.5 (98.0)
MPMA-*x*BED2A0D0-S2C			300 (11.8)							46.2 (101.7)
MPMA-*x*BEE4A0B8-S2C	440 (17.3)		180 (7.1)							46.7 (102.8)
MPMA-*x*BEE4A0D0-S2C			300 (11.8)							48.4 (106.6)
MPMA-*x*BEG8A0B8-S2C	680 (26.8)		180 (7.1)							51.2 (112.7)
MPMA-*x*BEG8A0D0-S2C			300 (11.8)							52.9 (116.9)

Table 30 - Allowable Payload Based Upon X-axis Acceleration and Z-axis Travel

X-axis Acceleration (1) g	Z-axis Travel mm (in.)	
	180	300
1.3	0.2	—
1.2	2.6	0.9
1.1	5.4	3.7
1.0	8.9	7.2
0.9	13.1	11.4

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded.

Table 31 - MPMA-*x*BE*xxxxxx-xxx* Product Dimensions

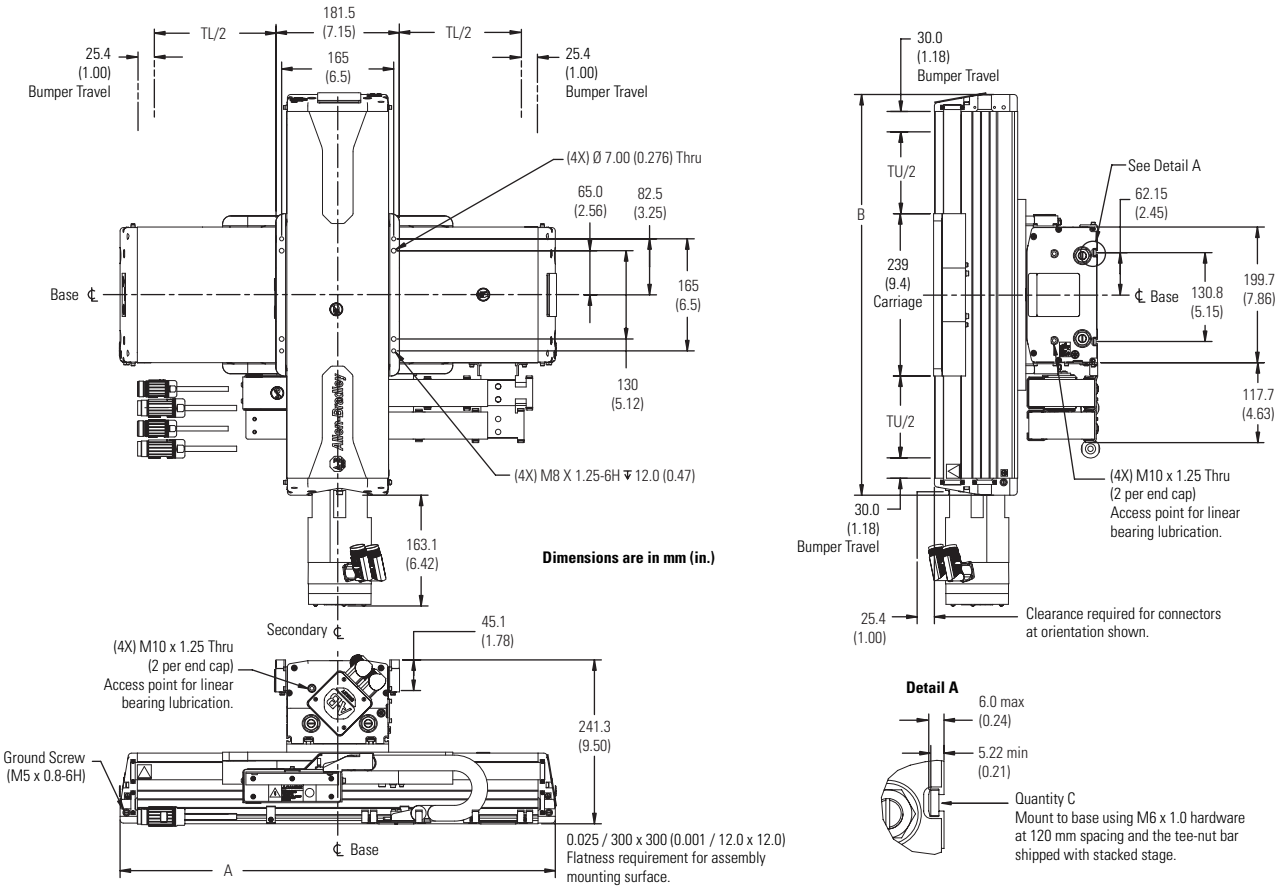


Table 32 - MPMA-*x*BE*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Z-axis)	TU Travel (Z-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-ABED2A0B8-S2C	761 (30.0)	320 (12.6)	530 (20.9)	180 (7.1)	12
MPMA-ABED2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABEE4A0B8-S2C	881 (34.7)	440 (17.3)	530 (20.9)	180 (7.1)	14
MPMA-ABEE4A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABEG8A0B8-S2C	1121 (44.1)	680 (26.8)	530 (20.9)	180 (7.1)	18
MPMA-ABEG8A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBED2A0B8-S2C	761 (30.0)	320 (12.6)	530 (20.9)	180 (7.1)	12
MPMA-BBED2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBEE4A0B8-S2C	881 (34.7)	440 (17.3)	530 (20.9)	180 (7.1)	14
MPMA-BBEE4A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBEG8A0B8-S2C	1121 (44.1)	680 (26.8)	530 (20.9)	180 (7.1)	18
MPMA-BBEG8A0D0-S2C			650 (25.6)	300 (11.8)	

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*BI*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Z stages with 200 mm frame ballscrew driven X-axis and 150 mm frame ballscrew driven Z-axis. Maximum payload is 25 kg (55.1 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 33 - MPMA-*x*BI*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*BID0A0B8-S2C	300 (11.8)	N/A	180 (7.1)	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)	N/A	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)	60	N/A	60	37.7 (83.0)
MPMA-*x*BID0A0D0-S2C			300 (11.8)							39.4 (86.8)
MPMA-*x*BIE2A0B8-S2C	420 (16.5)		180 (7.1)							39.7 (87.4)
MPMA-*x*BIE2A0D0-S2C			300 (11.8)							41.4 (91.2)
MPMA-*x*BIG6A0B8-S2C	660 (26.0)		180 (7.1)							43.5 (95.8)
MPMP-*x*BIG6A0D0-S2C			300 (11.8)							45.2 (99.5)

Table 34 - Allowable Payload Based Upon X-axis Acceleration and Z-axis Travel

X-axis Acceleration (1) g	Z-axis Travel mm (in.)	
	180	300
4	2.0	0.3
3.8	3.1	1.4
3.6	4.4	2.7
3.4	5.8	4.1
3.2	7.4	5.7
3	9.2	7.5
2.8	11.3	9.6
2.6	13.7	12.0
2.4	16.4	14.7
2.2	19.7	18.0
2	23.7	22.0

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded. Do not exceed 1.1 m/s maximum velocity of ballscrew axis.

Table 35 - MPMA-*x*BI*xxxxxx-xxx* Product Dimensions

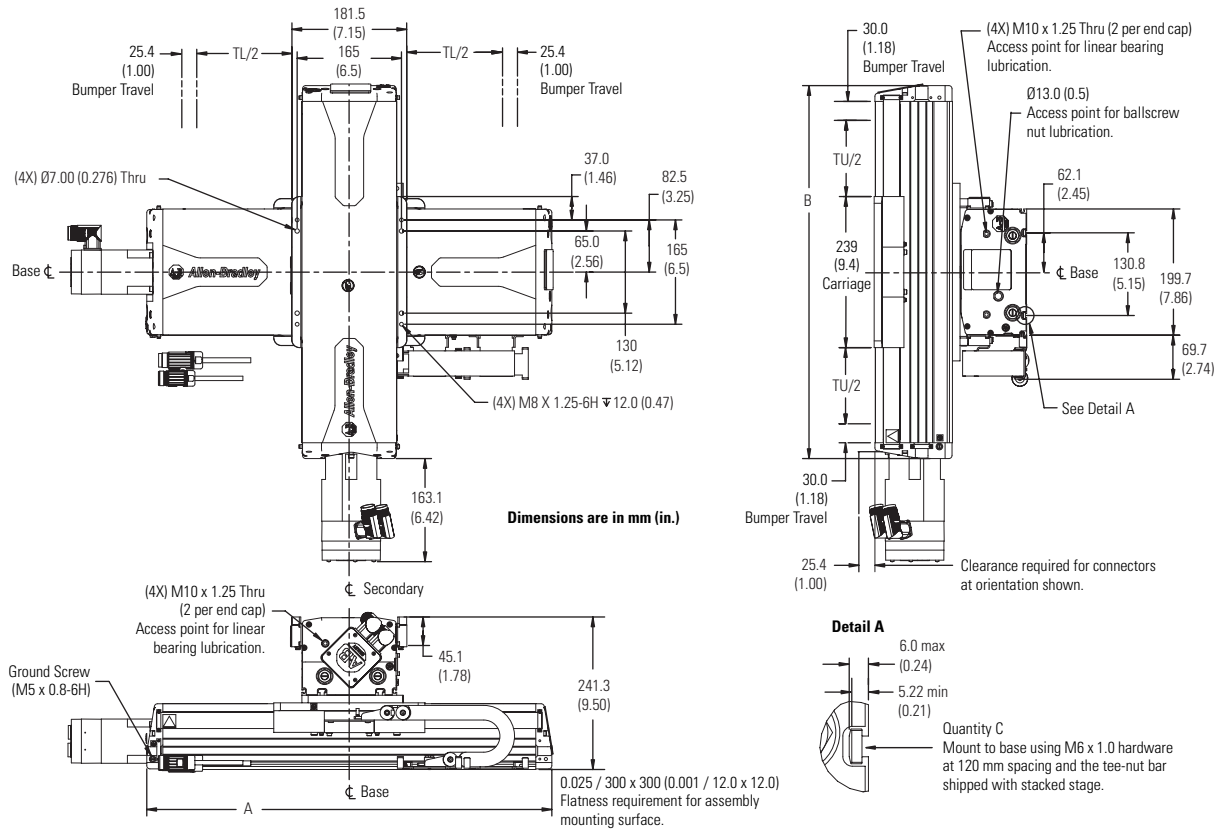


Table 36 - MPMA-*x*BI*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Z-axis)	TU Travel (Z-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-ABID0A0B8-S2C	641 (25.2)	300 (11.8)	530 (20.9)	180 (7.1)	10
MPMA-ABID0A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABIE2A0B8-S2C	761 (30.0)	420 (16.5)	530 (20.9)	180 (7.1)	12
MPMA-ABIE2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABIG6A0B8-S2C	1001 (39.4)	660 (26.0)	530 (20.9)	180 (7.1)	16
MPMA-ABIG6A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBID0A0B8-S2C	641 (25.2)	300 (11.8)	530 (20.9)	180 (7.1)	10
MPMA-BBID0A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBIE2A0B8-S2C	761 (30.0)	420 (16.5)	530 (20.9)	180 (7.1)	12
MPMA-BBIE2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBIG6A0B8-S2C	1001 (39.4)	660 (26.0)	530 (20.9)	180 (7.1)	16
MPMA-BBIG6A0D0-S2C			650 (25.6)	300 (11.8)	

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

MPMA-*x*BD*xxxxxx-xxx* Product Specifications and Dimensions

These specifications apply to Center Stacked X/Z stages with 250 mm frame linear motor driven X-axis and 150 mm frame ballscrew driven Z-axis. Maximum payload is 20 kg (44.0 lb). For heavier loads, contact your Rockwell Automation sales representative.

Table 37 - MPMA-*x*BD*xxxxxx-xxx* Product Specifications

Multi-axis Linear Stage Cat. No.	Travel mm (in.)			Encoder Type			Bi-directional Repeatability (µm)			Weight, Approx. kg (lb)
	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	X-axis	Y-axis	Z-axis	
MPMA-*x*BDD2A0B8-S2C	320 (12.6)	N/A	180 (7.1)	5 micron resolution incremental magnetic linear encoder (direct drive only)	N/A	Multi-turn high resolution encoder absolute feedback, 128 cycle/rev. (ballscrew only)	15	N/A	60	52.2 (114.9)
MPMA-*x*BDD2A0D0-S2C			300 (11.8)							53.9 (118.7)
MPMA-*x*BDE4A0B8-S2C	440 (17.3)		180 (7.1)							55.2 (121.5)
MPMA-*x*BDE4A0D0-S2C			300 (11.8)							56.9 (125.3)
MPMA-*x*BDE4A0E2-S2C			420 (16.5)							58.6 (129.0)
MPMA-*x*BDG8A0B8-S2C	680 (26.8)		180 (7.1)							61.7 (135.8)
MPMA-*x*BDG8A0D0-S2C			300 (11.8)							63.4 (139.6)
MPMA-*x*BDG8A0E2-S2C			420 (16.5)							65.1 (143.3)
MPMA-*x*BDI0A0B8-S2C	800 (31.5)		180 (7.1)							65.2 (143.5)
MPMA-*x*BDI0A0D0-S2C			300 (11.8)							66.9 (147.3)
MPMA-*x*BDI0A0E2-S2C			420 (16.5)							68.6 (151.0)
MPMA-*x*BDJ2A0D0-S2C	920 (36.2)		300 (11.8)							70.0 (154.1)
MPMA-*x*BDJ2A0E2-S2C			420 (16.5)							71.7 (157.8)
MPMA-*x*BDJ2A0F4-S2C			540 (21.3)							73.5 (161.8)

Table 38 - Allowable Payload Based Upon X-axis Acceleration and Z-axis Travel

X-axis Acceleration (1) g	Z-axis Travel mm (in.)			
	180	300	420	540
1.8	0.5	—	—	—
1.7	2.3	0.6	—	—
1.6	4.4	2.7	1.0	—
1.5	6.7	5.0	3.3	—
1.4	9.4	7.7	6.0	2.5
1.3	12.5	10.8	9.1	5.6
1.2	16.0	14.3	12.6	9.1
1.1	20.3	18.6	16.9	13.4
1.0	25.4	23.7	22.0	18.5

(1) Acceleration values are based on the motors instantaneous and average motor temperature limits not being exceeded.

Table 39 - MPMA-*x*BD*xxxxxx-xxx* Product Dimensions

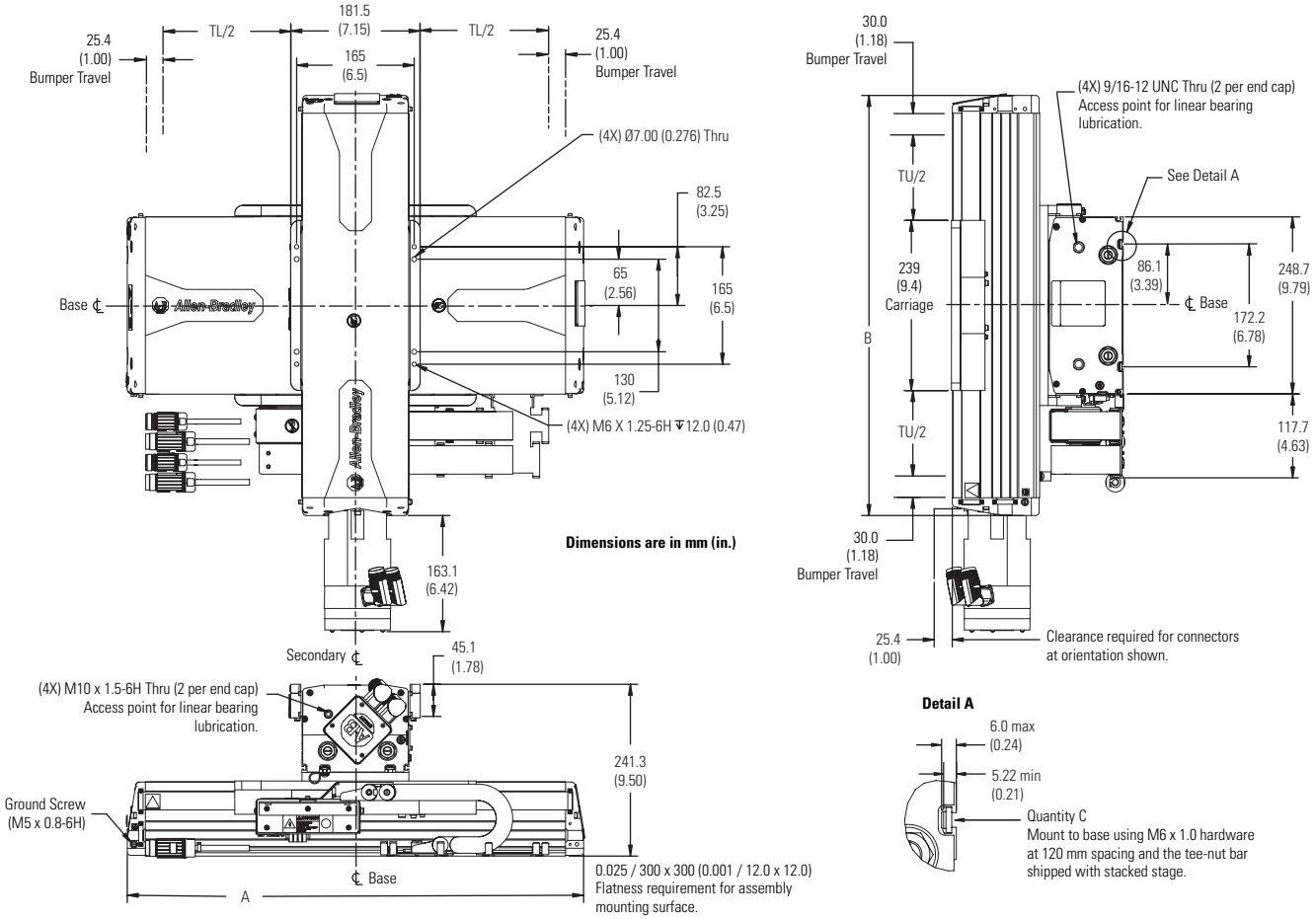


Table 40 - MPMA-*x*BD*xxxxxx-xxx* Dimensions

Multi-axis Linear Stage Cat. No.	A Stage Length (X-axis)	TL Travel (X-axis)	B Stage Length (Z-axis)	TU Travel (Z-axis)	C Mounting Locations (X-axis)
	mm (in.)	mm (in.)	mm (in.)	mm (in.)	Qty
MPMA-ABDD2A0B8-S2C	761 (30.0)	320 (12.6)	530 (20.9)	180 (7.1)	12
MPMA-ABDD2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABDE4A0B8-S2C	881 (34.7)	440 (17.3)	530 (20.9)	180 (7.1)	14
MPMA-ABDE4A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABDE4A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-ABDG8A0B8-S2C	1121 (44.1)	680 (26.8)	530 (20.9)	180 (7.1)	18
MPMA-ABDG8A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABDG8A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-ABDI0A0B8-S2C	1241 (48.9)	800 (31.5)	530 (20.9)	180 (7.1)	20
MPMA-ABDI0A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-ABDI0A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-ABDJ2A0D0-S2C	1361 (53.6)	920 (36.2)	650 (25.6)	300 (11.8)	22
MPMA-ABDJ2A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-ABDJ2A0F4-S2C			890 (35.0)	540 (21.3)	
MPMA-BBDD2A0B8-S2C	761 (30.0)	320 (12.6)	530 (20.9)	180 (7.1)	12
MPMA-BBDD2A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBDE4A0B8-S2C	881 (34.7)	440 (17.3)	530 (20.9)	180 (7.1)	14
MPMA-BBDE4A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBDE4A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-BBDG8A0B8-S2C	1121 (44.1)	680 (26.8)	530 (20.9)	180 (7.1)	18
MPMA-BBDG8A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBDG8A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-BBDI0A0B8-S2C	1241 (48.9)	800 (31.5)	530 (20.9)	180 (7.1)	20
MPMA-BBDI0A0D0-S2C			650 (25.6)	300 (11.8)	
MPMA-BBDI0A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-BBDJ2A0D0-S2C	1361 (53.6)	920 (36.2)	650 (25.6)	300 (11.8)	22
MPMA-BBDJ2A0E2-S2C			770 (30.3)	420 (16.5)	
MPMA-BBDJ2A0F4-S2C			890 (35.0)	540 (21.3)	

Actuators are designed to metric dimensions. Inch dimensions are approximate conversions from millimeters. Dimensions without tolerances are for reference.

Table 41 - Brake Specifications for Ball Screw Linear Stage Motors

Motor Cat. No.	Backlash (brake engaged) µm (in.)	Holding Force N (lb)	Coil Current (at 24V dc) A	Brake Response Time		
				Release ms	Engage - Suppression via MOV ms	Engage - Suppression via Diode ms
MPAS-*xxxxxx*-V05*x*A	100 (0.004)	5187 (1166)	0.46…0.56	50	20	42
MPAS-*xxxxxx*-V20*x*A		1294 (291)				

Table 42 - Environmental Specifications for Multi-axis Stages

Attribute	Value
Ambient temperature	0…40 °C (32…104 °F)
Storage temperature	-30…70 °C (-22…158 °F)
Relative humidity	5%…95% noncondensing
Shock	20 g peak, 6 ms duration
Vibration	0.1 grms @ Hz, 30…2000 Hz
Ball screw lifetime	300,000 krevs, with a 11.4 kg (25 lb) max load, 1g max acceleration, in a clean and dry environment, with lubrication intervals that do not exceed 150,000 krevs or 3 months.
Cable carrier lifetime	10,000,000 cycles Direct drive linear stages require lubrication every 6 months of 5,000 km of travel. Ball screw linear stages require lubrication every 3 months or 150,000,000 revolutions. Use the MP-Series Integrated Linear Stage grease pump kit, and additional grease cartridges if needed.
Pressurized air (ball screw only)	Plastic air tubing should be 6 mm (0.2362 in.) OD Teflon FEP tubing. Air supplied to the stage should not exceed 270 kpa (40 psi). Maximum flow rate 15 SCFM based on 4mm ID tube and 0.5m max length.

PTC Thermal Signal

Temperature °C (°F)	Resistance in Ohms (1)
Up to 100 (212)	≤ 750
Up to 105 (221)	≤ 7500
Up to 110 (230)	≥ 10,000

(1) Measure the resistance of the thermistor in a direct drive linear stage on the feedback connector at pins 13 and 14 respectively; see Feedback Connector for Direct Drive Linear Stage on page 44 for more information.

Certifications

Refer to the Initiator Product Certification website, http://www.ab.com, for Declarations of Conformity Certificates applicable to this product.

Notes:

Accessories

Introduction

This chapter shows accessories for the stacked stages.

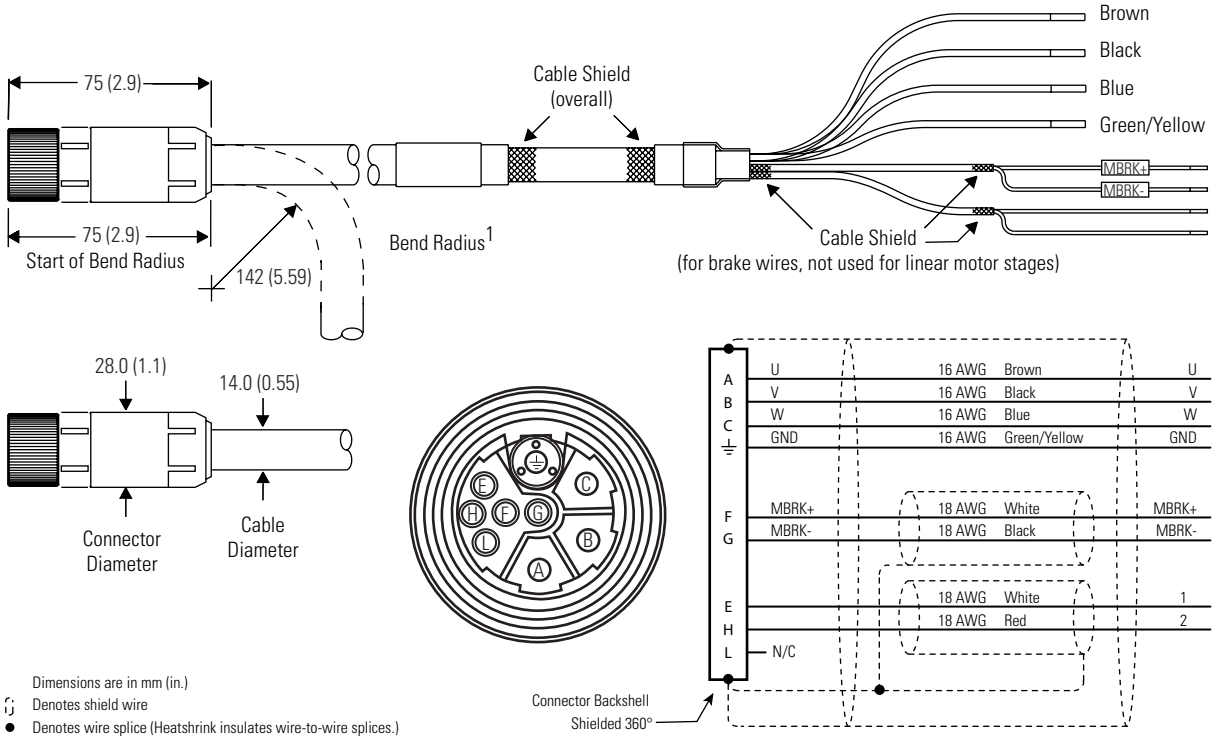
Topic	Page
Interconnect Cables	103
Installation, Maintenance, and Replacement Kits	106

Interconnect Cables

Linear stages connect to a drive through a power and a feedback cables.

Power Cable Dimensions, Pinout, and Schematic (2090-XXNPMF-16S*xx*)

You can use a cable length of up to 10 m (32.8 ft) for MPAS-*xxxxxx*-ALM*xxx* and up to 30 m (98.4 ft) for MPAS-*xxxxxx*-V*xxxxx*.



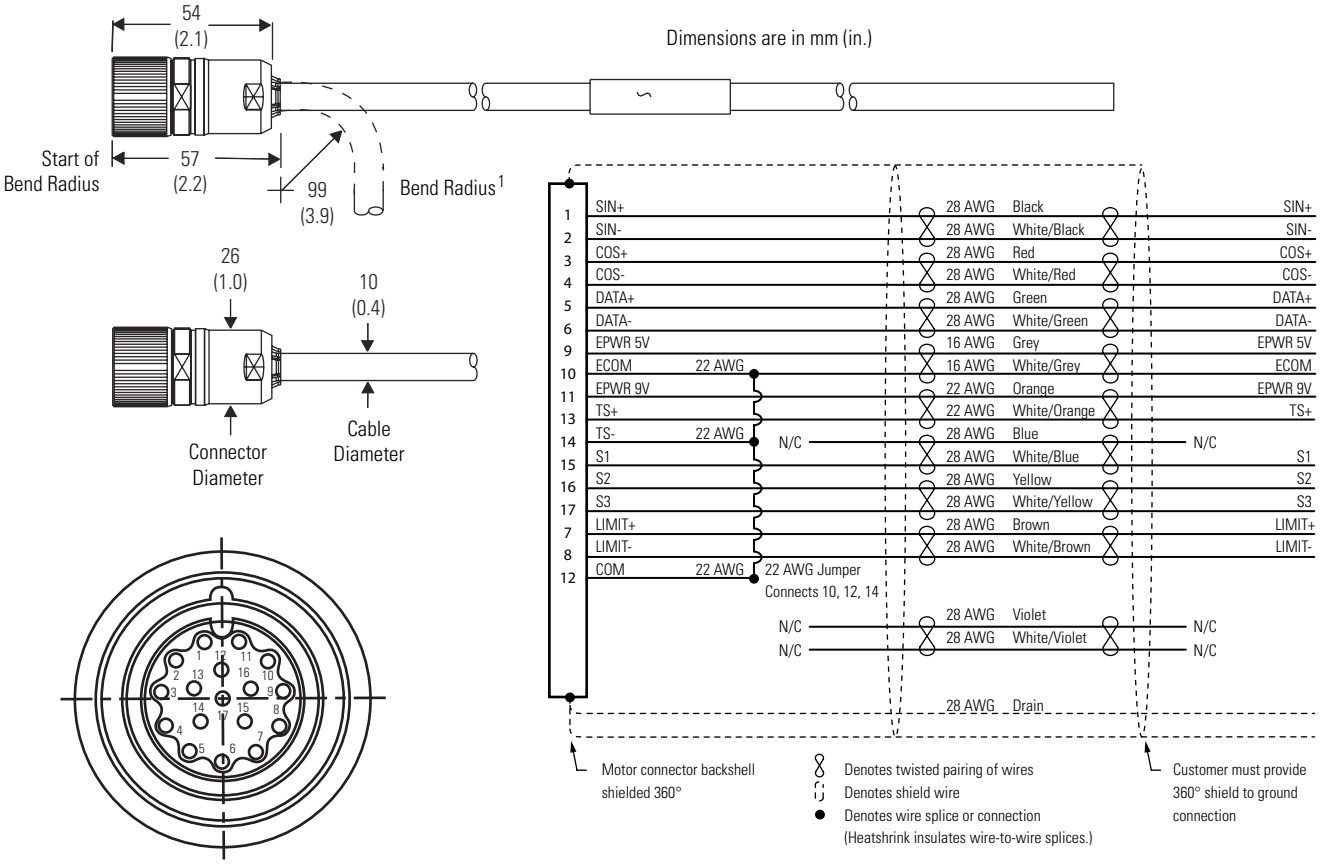
1 Bend radius (BR) is the specified minimum bend radius for cable assemblies. For standard cable, BR is a one-time flex application. Flex cables have a much higher BR to withstand flex applications.

Table 43 - Power Cable Pinout (2090-XXNPMF-16S*xx*)

Pin	Gauge	Color	Signal Designation	
A	16	Brown	U	
B	16	Black	V	
C	16	Blue	W	
GND	16	Green/Yellow	GND	
F	18	White	MBRK+	Brake
G	18	Black	MBRK-	
E	18	White	1	Not used
H	18	Red	2	
L	N/A	N/A	N/A	
SHIELD	N/A	N/A	N/A	

Feedback Cable Dimensions, Pinout, and Schematic (2090-XXNFMF-S*xx*)

You can use a cable length of up to 10 m (32.8 ft) for MPAS-*xxxxxx*-ALM*xxx* and up to 30 m (98.4 ft) for MPAS-*xxxxxx*-V*xxxxx*.



1 Bend radius (BR) is the specified minimum bend radius for cable assemblies. For standard cable, BR is a one-time flex application. Flex cables have a much higher BR to withstand flex applications.

Installation, Maintenance, and Replacement Kits

Accessories available for installing linear stages, replacing items, and performing maintenance at regular intervals are listed in the tables that follow.

Table 44 - Accessory Kits Common to All Multi-axis Linear Stages

Linear Stage Cat. No.	Description	Accessory Cat. No.
MPAS-A/B*xxxx*	Kit, grease gun for all integrated linear stages.	MPAS-GPUMP
	Grease gun refill cartridge for all integrated linear stages.	MPAS-CART
MPAS-A8*xxx*, MPAS-B8*xxx*	Kit, Tee-nuts (10 per package).	MPAS-8-TNUT
MPAS-A9*xxx*, MPAS-B9*xxx*		MPAS-9-TNUT

Table 45 - Accessory Kits for Multi-axis Direct-drive Linear Stages

Linear Stage Cat. No.	Description	Accessory Cat. No.
MPAS-*x*6*xxxx*-ALMS2*x*	Kit, strip seal for direct-drive linear stage.	MPAS-6*xxx*B-SEAL (1)
MPAS-*x*8*xxxx*-ALMS2*x*		MPAS-8*xxx*E-SEAL (2)
MPAS-*x*9*xxxx*-ALMS2*x*		MPAS-9*xxx*K-SEAL (2)
MPAS-*x*6*xxxx*-ALMS2*x*	Kit, side covers for direct-drive linear stage.	MPAS-6*xxx*B-SIDE (1)
MPAS-*x*8*xxxx*-ALMS2*x*		MPAS-8*xxx*E-SIDE (2)
MPAS-*x*9*xxxx*-ALMS2*x*		MPAS-9*xxx*K-SIDE (2)
MPAS-*x*6*xxxx*-ALMS2*x*	Kit, top cover for direct-drive linear stage.	MPAS-6*xxx*B-TOP (1)
MPAS-*x*8*xxxx*-ALMS2*x*		MPAS-8*xxx*E-TOP (2)
MPAS-*x*9*xxxx*-ALMS2*x*		MPAS-9*xxx*K-TOP (2)

(1) Variable *xxx* (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, 102, or 114.
(2) Variable *xxx* (mm stroke x 10) is 014, 020, 026, 032, 038, 044, 056, 068, 080, 092, 104, 128, 152, 176, or 194.

Table 46 - Accessory Kits for Multi-axis Ballscrew Linear Stages

Linear Stage Cat. No.	Description	Accessory Cat. No.
MPAS-*x*6*xxxx*-V*xx*S*xx*	Coupler, for ballscrew linear stage.	MPAS-6-COUP
MPAS-*x*8*xxxx*-V*xx*S*xx*		MPAS-8-COUP
MPAS-*x*9*xxxx*-V*xx*S*xx*		MPAS-9-COUP
MPAS-A*xxxx*1-V05S2*x*	Motor, 230V, without brake for 5 mm/rev ballscrew linear stage.	MPLS-A210E-VJ42AA
MPAS-A*xxxx*1-V05S4*x*	Motor, 230V, with brake for 5 mm/rev ballscrew linear stage.	MPLS-A210E-VJ44AA
MPAS-B*xxxx*1-V05S2*x*	Motor, 460V, without brake for 5 mm/rev ballscrew linear stage.	MPLS-B210E-VJ42AA
MPAS-B*xxxx*1-V05S4*x*	Motor, 460V, with brake for 5 mm/rev ballscrew linear stage.	MPLS-B210E-VJ44AA
MPAS-A*xxxx*2-V20S2*x*	Motor, 230V, without brake for 20 mm/rev ballscrew linear stage.	MPLS-A220H-VJ42AA
MPAS-A*xxxx*2-V20S4*x*	Motor, 230V with brake for 20 mm/rev ballscrew linear stage.	MPLS-A220H-VJ44AA
MPAS-B*xxxx*2-V20S2*x*	Motor, 460V, without brake for 20 mm/rev ballscrew linear stage.	MPLS-B220H-VJ42AA
MPAS-B*xxxx*2-V20S4*x*	Motor, 460V with brake for 20 mm/rev ballscrew linear stage.	MPLS-B220H-VJ44AA
MPAS-*x*6*xxxx*-V*xx*S*xx*	Kit, strip seal for ballscrew linear stage.	MPAS-6*xxx*1-SEAL (1)
MPAS-*x*8*xxxx*-V*xx*S*xx*		MPAS-8*xxx*1-SEAL (2)
MPAS-*x*9*xxxx*-V*xx*S*xx*		MPAS-9*xxx*1-SEAL (2)
MPAS-*x*6*xxxx*-V*xx*S*xx*	Kit, side cover for ballscrew linear stage.	MPAS-6*xxx*1-SIDE (1)
MPAS-*x*8*xxxx*-V*xx*S*xx*		MPAS-8*xxx*1-SIDE (2)
MPAS-*x*9*xxxx*-V*xx*S*xx*		MPAS-9*xxx*1-SIDE (2)
MPAS-*x*6*xxxx*-V*xx*S*xx*	Kit, top cover for ballscrew linear stage.	MPAS-6*xxx*1-TOP (1)
MPAS-*x*8*xxxx*-V*xx*S*xx*		MPAS-8*xxx*1-TOP (2)
MPAS-*x*9*xxxx*-V*xx*S*xx*		MPAS-9*xxx*1-TOP (2)

(1) Variable *xxx* (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, or 066.
(2) Variable *xxx* (mm stroke x 10) is 012, 018, 024, 030, 036, 042, 054, 066, 078, 090, or 102.

Table 47 - Accessory Kits for Center Multi-axis X/Y Cable Modules

Multi-axis Linear Stage Cat. No.	Description	Accessory Cat. No.
MPMA-*x*ABC0C0A0-*xxx*	Cable track module for MPMA-*x*AB series X/Y Center Stacked Stages	MPMA-*x*ABC0C0A0-CBL
MPMA-*x*ABC6C6A0-*xxx*		MPMA-*x*ABC6C6A0-CBL
MPMA-*x*ABD2D2A0-*xxx*		MPMA-*x*ABD2D2A0-CBL
MPMA-*x*ABD8D8A0-*xxx*		MPMA-*x*ABD8D8A0-CBL
MPMA-*x*ABE4E4A0-*xxx*		MPMA-*x*ABE4E4A0-CBL
MPMA-*x*ABF6F6A0-*xxx*		MPMA-*x*ABF6F6A0-CBL
MPMA-*x*ACB4B4A0-*xxx*	Cable track module for MPMA-*x*AC series X/Y Center Stacked Stages	MPMA-*x*ACB4B4A0-CBL
MPMA-*x*ACC0C0A0-*xxx*		MPMA-*x*ACC0C0A0-CBL
MPMA-*x*ACC6C6A0-*xxx*		MPMA-*x*ACC6C6A0-CBL
MPMA-*x*ACD2D2A0-*xxx*		MPMA-*x*ACD2D2A0-CBL
MPMA-*x*APB8B8A0-*xxx*	Cable track module for MPMA-*x*AP series X/Y Center Stacked Stages	MPMA-*x*APB8B8A0-CBL
MPMA-*x*APC4C4A0-*xxx*		MPMA-*x*APC4C4A0-CBL
MPMA-*x*APD0D0A0-*xxx*		MPMA-*x*APD0D0A0-CBL
MPMA-*x*APE2E2A0-*xxx*		MPMA-*x*APE2E2A0-CBL
MPMA-*x*APG6G6A0-*xxx*		MPMA-*x*APG6G6A0-CBL

Table 48 - Accessory Kits for Cartesian Multi-axis X/Y Cable Modules

Multi-axis Linear Stage Cat. No.	Description	Accessory Cat. No.
MPMA-*x*CBD2D2A0-*xxx*	Cable track module for MPMA-*x*CB series X/Y Cartesian Stacked Stages	MPMA-*x*CBD2D2A0-CBL
MPMA-*x*CBE4D2A0-*xxx*		MPMA-*x*CBE4D2A0-CBL
MPMA-*x*CBE4E4A0-*xxx*		MPMA-*x*CBE4E4A0-CBL
MPMA-*x*CBF6E4A0-*xxx*		MPMA-*x*CBF6E4A0-CBL
MPMA-*x*CBG8E4A0-*xxx*		MPMA-*x*CBG8E4A0-CBL
MPMA-*x*CBG8F6A0-*xxx*		MPMA-*x*CBG8F6A0-CBL
MPMA-*x*CBI0F6A0-*xxx*		MPMA-*x*CBI0F6A0-CBL
MPMA-*x*CBJ2F6A0-*xxx*		MPMA-*x*CBJ2F6A0-CBL
MPMA-*x*CQD0D0A0-*xxx*	Cable track module for MPMA-*x*CQ series X/Y Cartesian Stacked Stages	MPMA-*x*CQD0D0A0-CBL
MPMA-*x*CQE2D0A0-*xxx*		MPMA-*x*CQE2D0A0-CBL
MPMA-*x*CQE2E2A0-*xxx*		MPMA-*x*CQE2E2A0-CBL
MPMA-*x*CQG6E2A0-*xxx*		MPMA-*x*CQG6E2A0-CBL
MPMA-*x*CQG6G6A0-*xxx*		MPMA-*x*CQG6G6A0-CBL
MPMA-*x*CQH8G6A0-*xxx*		MPMA-*x*CQH8G6A0-CBL
MPMA-*x*CQJ0G6A0-*xxx*		MPMA-*x*CQJ0G6A0-CBL

Table 49 - Accessory Kits for Center Multi-axis X/Z Cable Modules

Multi-axis Linear Stage Cat. No.	Description	Accessory Cat. No.
MPMA-*x*BDD2A0B8-*xxx*	Cable track module for MPMA-*x*BD series X/Z Center Stacked Stages	MPMA-xBDD2A0B8-CBL
MPMA-*x*BDD2A0D0-*xxx*		MPMA-xBDD2A0D0-CBL
MPMA-*x*BDE4A0B8-*xxx*		MPMA-xBDE4A0B8-CBL
MPMA-*x*BDE4A0D0-*xxx*		MPMA-*x*BDE4A0D0-CBL
MPMA-*x*BDE4A0E2-*xxx*		MPMA-*x*BDE4A0E2-CBL
MPMA-*x*BDG8A0B8-*xxx*		MPMA-*x*BDG8A0B8-CBL
MPMA-*x*BDG8A0D0-*xxx*		MPMA-*x*BDG8A0D0-CBL
MPMA-*x*BDG8A0E2-*xxx*		MPMA-*x*BDG8A0E2-CBL
MPMA-*x*BDI0A0B8-*xxx*		MPMA-*x*BDI0A0B8-CBL
MPMA-*x*BDI0A0D0-*xxx*		MPMA-*x*BDI0A0D0-CBL
MPMA-*x*BDI0A0E2-*xxx*		MPMA-*x*BDI0A0E2-CBL
MPMA-*x*BDJ2A0D0-*xxx*		MPMA-*x*BDJ2A0D0-CBL
MPMA-*x*BDJ2A0E2-*xxx*		MPMA-*x*BDJ2A0E2-CBL
MPMA-*x*BDJ2A0F4-*xxx*		MPMA-*x*BDJ2A0F4-CBL
MPMA-*x*BED2A0B8-*xxx*	Cable track module for MPMA-*x*BE series X/Z Center Stacked Stages	MPMA-*x*BED2A0B8-CBL
MPMA-*x*BED2A0D0-*xxx*		MPMA-*x*BED2A0D0-CBL
MPMA-*x*BEE4A0B8-*xxx*		MPMA-*x*BEE4A0B8-CBL
MPMA-*x*BEE4A0D0-*xxx*		MPMA-*x*BEE4A0D0-CBL
MPMA-*x*BEG8A0B8-*xxx*		MPMA-*x*BEG8A0B8-CBL
MPMA-*x*BEG8A0D0-*xxx*		MPMA-*x*BEG8A0D0-CBL
MPMA-*x*BID0A0B8-*xxx*	Cable track module for MPMA-*x*BI series X/Z Center Stacked Stages	MPMA-*x*BID0A0B8-CBL
MPMA-*x*BID0A0D0-*xxx*		MPMA-*x*BID0A0D0-CBL
MPMA-*x*BIE2A0B8-*xxx*		MPMA-*x*BIE2A0B8-CBL
MPMA-*x*BIE2A0D0-*xxx*		MPMA-*x*BIE2A0D0-CBL
MPMA-*x*BIG6A0B8-*xxx*		MPMA-*x*BIG6A0B8-CBL
MPMP-*x*BIG6A0D0-*xxx*		MPMP-*x*BIG6A0D0-CBL

Table 50 - Mounting Bar Accessory Kits for Multi-axis X-axis Linear Stages

Multi-axis Linear Stage Cat. No.	Description	Accessory Cat. No.
MPMA-*xxx*B4*xxxx-xxx*	Mounting Bar for X-axis having B4 travel	MPAS-TBAR-B4
MPMA-*xxx*B8*xxxx-xxx*	Mounting Bar for X-axis having B8 travel	MPAS-TBAR-B8
MPMA-*xxx*C0*xxxx-xxx*	Mounting Bar for X-axis having C0 travel	MPAS-TBAR-C0
MPMA-*xxx*C4*xxxx-xxx*	Mounting Bar for X-axis having C4 travel	MPAS-TBAR-C4
MPMA-*xxx*C6*xxxx-xxx*	Mounting Bar for X-axis having C6 travel	MPAS-TBAR-C6
MPMA-*xxx*D0*xxxx-xxx*	Mounting Bar for X-axis having D0 travel	MPAS-TBAR-D0
MPMA-*xxx*D2*xxxx-xxx*	Mounting Bar for X-axis having D2 travel	MPAS-TBAR-D2
MPMA-*xxx*D8*xxxx-xxx*	Mounting Bar for X-axis having D8 travel	MPAS-TBAR-D8
MPMA-xxxE2*xxxx-xxx*	Mounting Bar for X-axis having E2 travel	MPAS-TBAR-E2
MPMA-*xxx*E4*xxxx-xxx*	Mounting Bar for X-axis having E4 travel	MPAS-TBAR-E4
MPMA-*xxx*F6*xxxx-xxx*	Mounting Bar for X-axis having F6 travel	MPAS-TBAR-F6
MPMA-*xxx*G6*xxxx-xxx*	Mounting Bar for X-axis having G6 travel	MPAS-TBAR-G6
MPMA-*xxx*G8*xxxx-xxx*	Mounting Bar for X-axis having G8 travel	MPAS-TBAR-G8
MPMA-*xxx*H8*xxxx-xxx*	Mounting Bar for X-axis having H8 travel	MPAS-TBAR-H8
MPMA-*xxx*I0*xxxx-xxx*	Mounting Bar for X-axis having I0 travel	MPAS-TBAR-I0
MPMA-*xxx*J0*xxxx-xxx*	Mounting Bar for X-axis having J0 travel	MPAS-TBAR-J0
MPMA-*xxx*J2*xxxx-xxx*	Mounting Bar for X-axis having J2 travel	MPAS-TBAR-J2

Interconnect Diagrams

Introduction

This appendix provides wiring examples to assist you in wiring an MPAS linear stage to a Allen-Bradley drive.

Topic	Page
Wiring Examples	111
Motor/Axis Module Wiring Examples	112

Wiring Examples

The notes below apply to the wiring examples on the pages that follow. Not all of the notes apply to each example.

Note	Information
1	Cable shield clamp must be used in order to meet CE requirements. No external connection to ground is required.
2	The Kinetix 2000 or Kinetix 6000 axis module referenced is either an individual axis module or the same axis module that resides within an multi-axis system.
3	For motor cable specifications, refer to the Kinetix Motion Control Selection Guide, publication GMC-SG001.
4	MPAS-A*xxxxxx* encoders use the +5V dc supply. MPAS-B*xxxxxx* encoders use +9V dc.
5	Use a flyback diode for noise suppression of the motor brake coil of an Ultra3000 drive. For more information, refer to System Design for Control of Electrical Noise, publication GMC-RM001.

Motor/Axis Module Wiring Examples

Figure 15 - Wiring Examples for MP-Series Integrated Linear Stages and Kinetix 2000 Drives

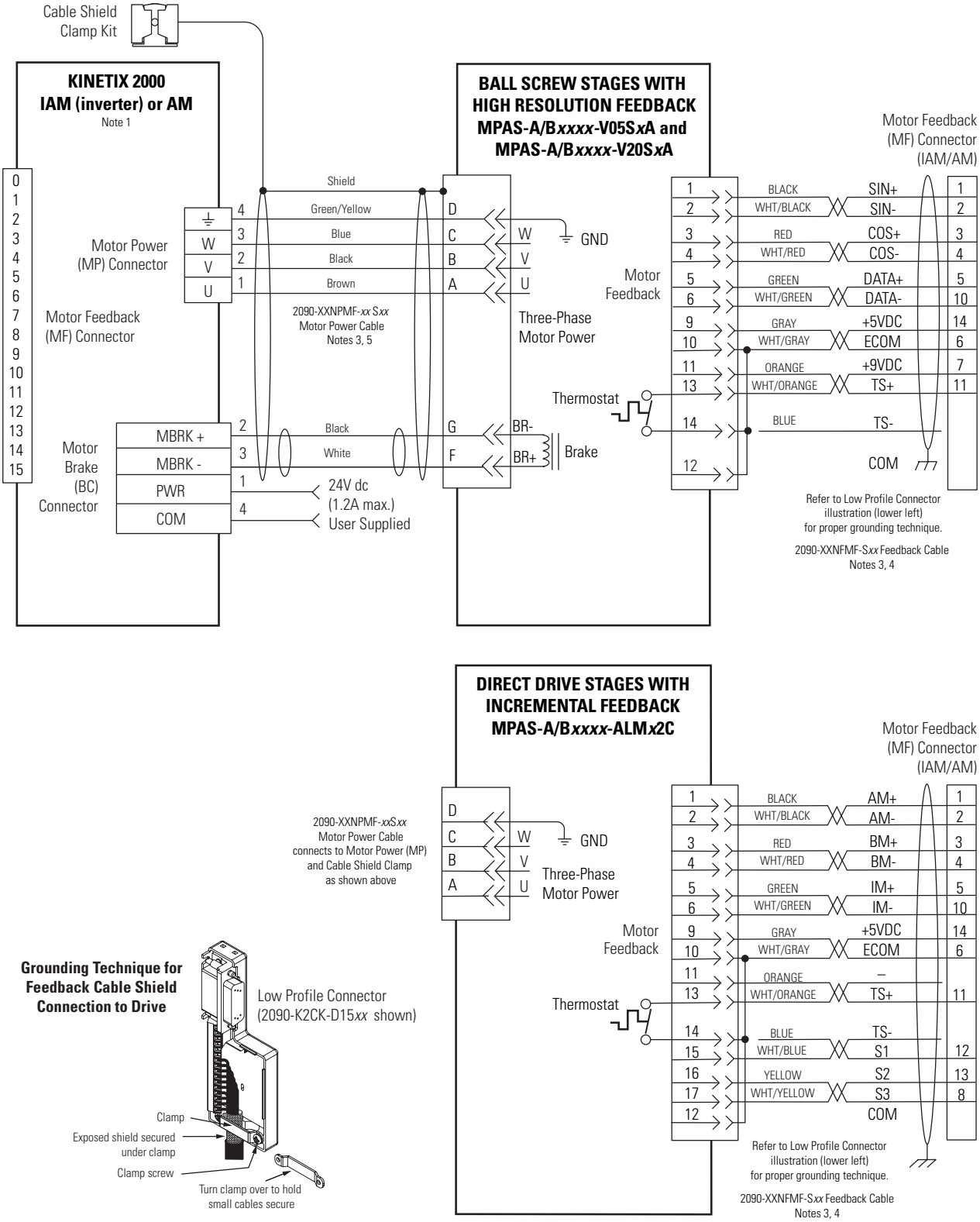


Figure 16 - Wiring Examples for MP-Series Integrated Linear Stages and Kinetix 6000 Drives

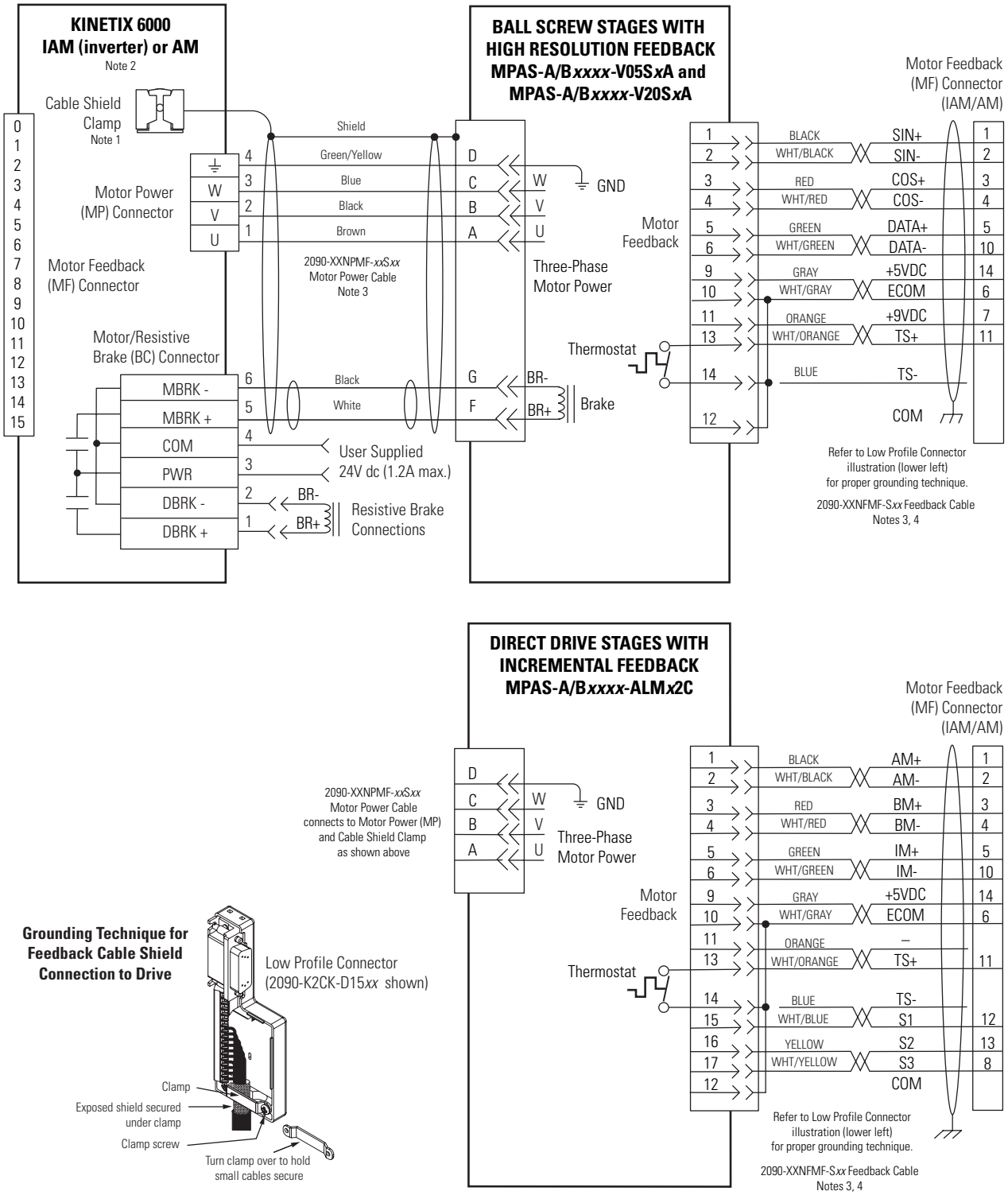
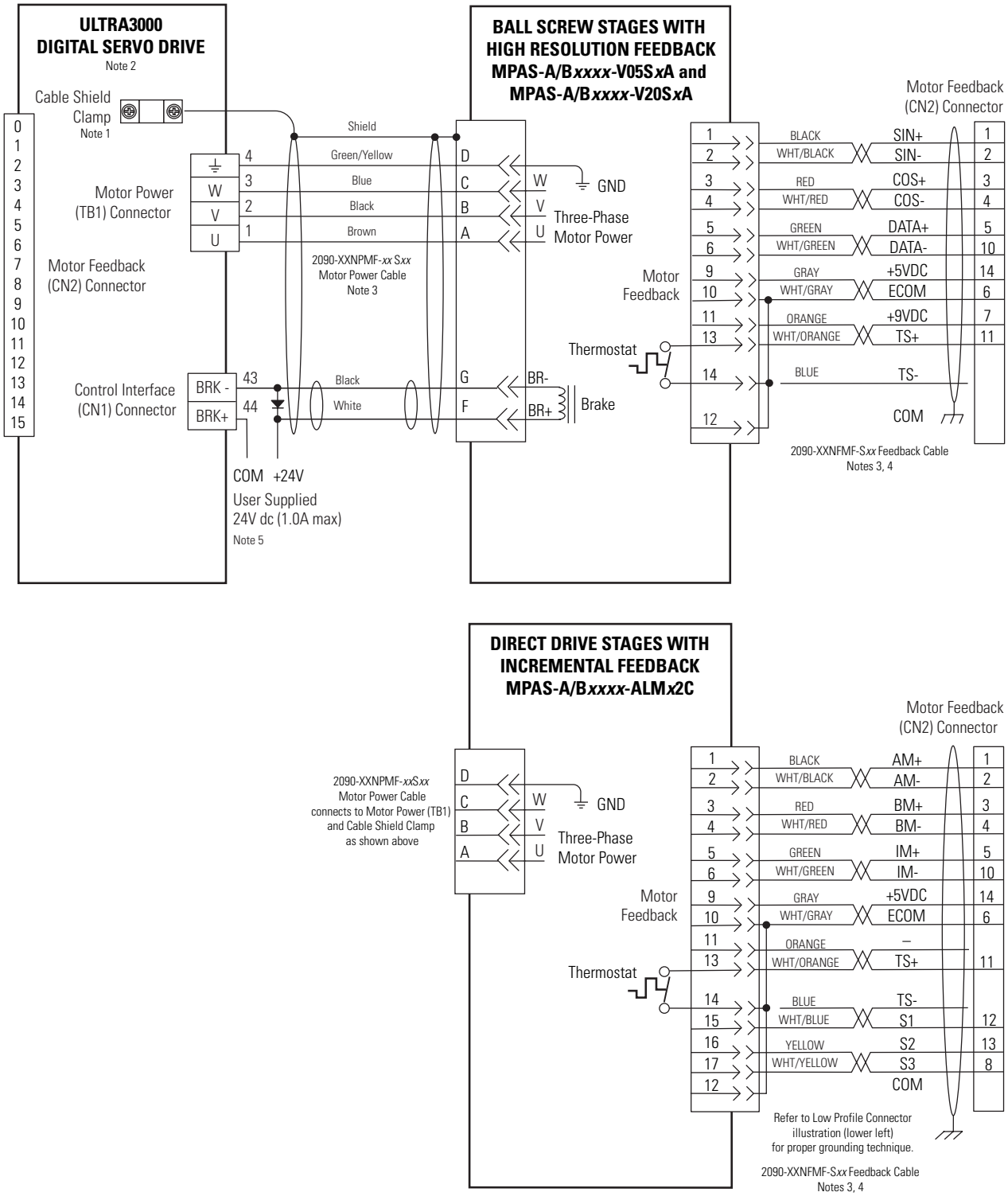


Figure 17 - Wiring Examples for MP-Series Integrated Linear Stages and Ultra3000 Drives



Home to Torque-level Example

Introduction

Use this appendix to become familiar with the Home to Torque-level sequence in RSLogix 5000 software, version 16 or later, and the considerations required when using this homing method.

This document provides an example for a typical homing program routine. The example shown does not claim to be complete and does not apply to any specific application.

Topic	Page
Applicable Drives	115
About Home to Torque-level Homing	116
Drive Bipolar Torque Limit Adjustment	118
Disable Soft Overtravel Limit	119
Ladder Code Example	119
Potential for Position Error	126

Applicable Drives

This information in this document applies to the following drives:

Drive Type	Cat. No.
Kinetix 2000	2093-AC05-MP*x*, 2093-AM*xx*
Kinetix 6000	2094-AC*xx*-M*xx*, 2094-AM*xx*, 2094-AC*xx*-M*xx*-S, 2094-AM*xx*-S, 2094-BC*xx*-M*xx*, 2094-BM*xx*, 2094-BC*xx*-M*xx*-S, 2094-BM*xx*-S

About Home to Torque-level Homing

Home to torque-level homing is a process that references a known position by monitoring torque while driving an axis into a mechanical hard-stop. Once the actual torque level reaches or exceeds a specified torque level for a set time of 500 ms, a status flag is set in the controller.

IMPORTANT Because the process of home to torque-level requires axis motion, the axis homing mode must be configured as Active.

Figure 18 - Axis Properties - Homing Tab

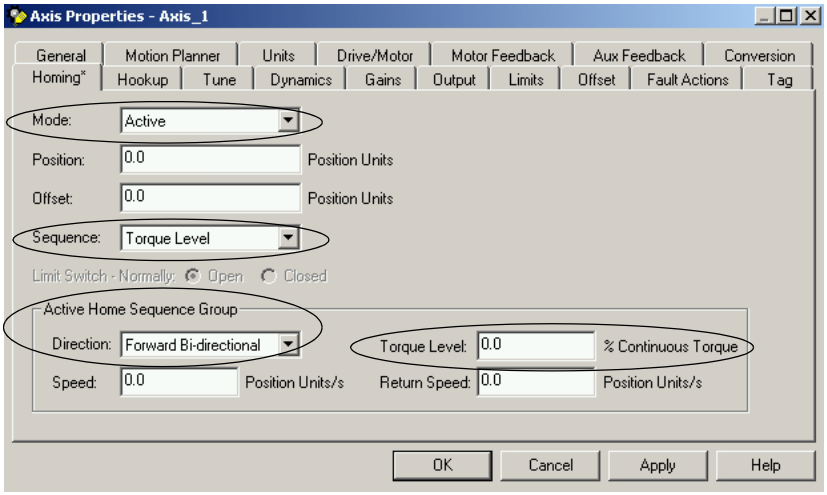


Table 51 - Torque-level Homing

Sequence Type	Description
Torque Level	Sets the Home Position after the output torque reaches the Torque Level value, reverses direction, and moves until the Homing Torque Above Threshold bit is low and the status bit sets.
Torque Level - Marker	Sets the Home Position after the output torque reaches the Torque Level value, reverses direction, and encounters an encoder marker.

When either the Torque Level or Torque Level - Marker homing option is selected on the Homing tab, the Torque Level field is activated in the Active Home Sequence Group. The units for this field are a percentage of the continuous torque of the motor (% Continuous Torque) limited by the drive-rated current/motor-rated current ratio. This number is interpreted in the drive as an absolute value and the range is 0 through the TorqueLimitPositive value.

Forward Bi-directional and Reverse Bi-directional are the only options for the Direction field when Torque Level or Torque Level - Marker homing sequence is selected. Uni-directional homing is not possible, because the Home to Torque-level sequence relies on a mechanical hard-stop.

Figure 19 - Position/Velocity Diagram for Torque-level Homing

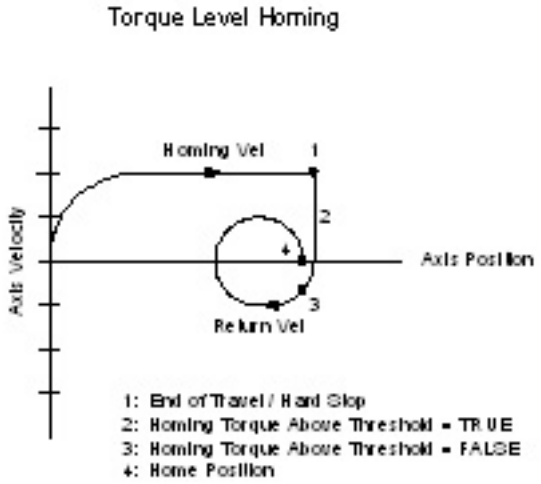
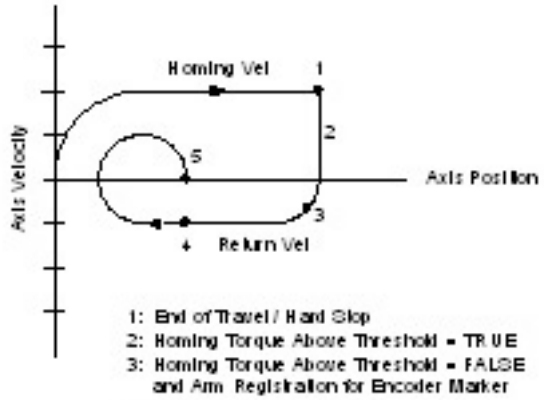


Figure 20 - Position/Velocity Diagram for Torque-level - Marker Homing



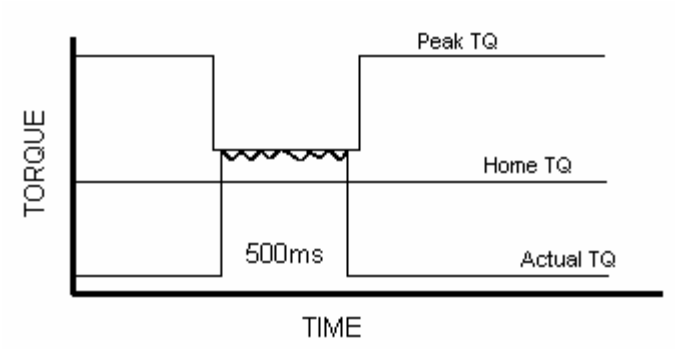
Drive Bipolar Torque Limit Adjustment

When homing an axis to a mechanical hard-stop, set the Home Torque-level value above the torque value required to move the system, but low enough not to cause problems with the system mechanics. As part of the process of homing to a torque limit, limit the Peak Torque value to a level 10% above the Home Torque value to reduce the stresses on the mechanics and to eliminate the chance of an over-current error.

IMPORTANT	The 10% value is an estimated starting point. This value may need adjustment based on the application requirements.

Limit the Peak Torque value before issuing the homing instruction (MAH) and reset the Peak Torque field to the original value after homing completes.

Table 52 - Bipolar Torque Limit Adjustment



Disable Soft Overtravel Limit

If the application requires the use of soft-overtravel limits (Limits tab) to safeguard the system mechanics, disable the Soft Travel Limits for the axis to home. The Soft Travel Limits are disabled to prevent a fault from occurring during the homing operation, but re-enable them after homing completes.

IMPORTANT	Those responsible for the application must determine when it is safe and appropriate to disable soft-overtravel checking.

Ladder Code Example

This example shows how to adjust the peak torque limit and disable the soft-overtravel limit checking when homing to a torque limit. The code uses a state model methodology in which each rung of code needs to complete successfully before moving to the next rung.

IMPORTANT	Because the home to torque-level sequence relies on the mechanical end of travel for operation, Uni-directional homing is not possible. You must choose between Forward Bi-directional or Reverse Bi-directional.

Rung 11 of the ladder code checks to make sure that the axis position, after homing, is within the Soft Travel Limits before re-enabling soft-overtravel limit checking. In this example, a 1.15 cm Offset move is configured in the Homing tab and that is the final home position. The 0.5 cm is within the Soft Travel Limits set on the Limits tab.

Table 53 - Tags Used

Tag Name	Data Type	Description
Saved_FaultConfig	DINT	Storage location for FaultConfigurationBits (motion attributes) Bit 0 = soft-overtravel limit checking
Clear_SoftOT_Mask	DINT	Set to -2. This masks the off soft-overtravel enable bit without changing the other configuration bits.
Temp_FaultConfig	DINT	Temporary hold word for FaultConfigurableBits
SoftOT_Disabled	BOOL	Soft-overtravel checking disabled status bit
Saved_TQLim_Bipolar	REAL	Storage location for Peak Torque (TorqueLimitBipolar)
HomeTQ_Level	REAL	Home Torque Level from the Home tab in Axis Properties
Temp_TQLim_Bipolar	REAL	Temporary Peak Torque for Homing (10% higher than Home Torque Limit)
Axis_01_MI.MAH	MOTION_INSTRUCTION	Control for MAH instruction (using a UDT)
Positive_Overtravel	REAL	Max Positive Soft-overtravel value
Negative_Overtravel	REAL	Max Negative Soft-overtravel value
Saved_PosErrorTol	REAL	Storage location for Actual Position Error value
Temp_PosErrorTol	REAL	Temporary Position Error value for Homing

Figure 21 - Axis Properties - Homing Tab

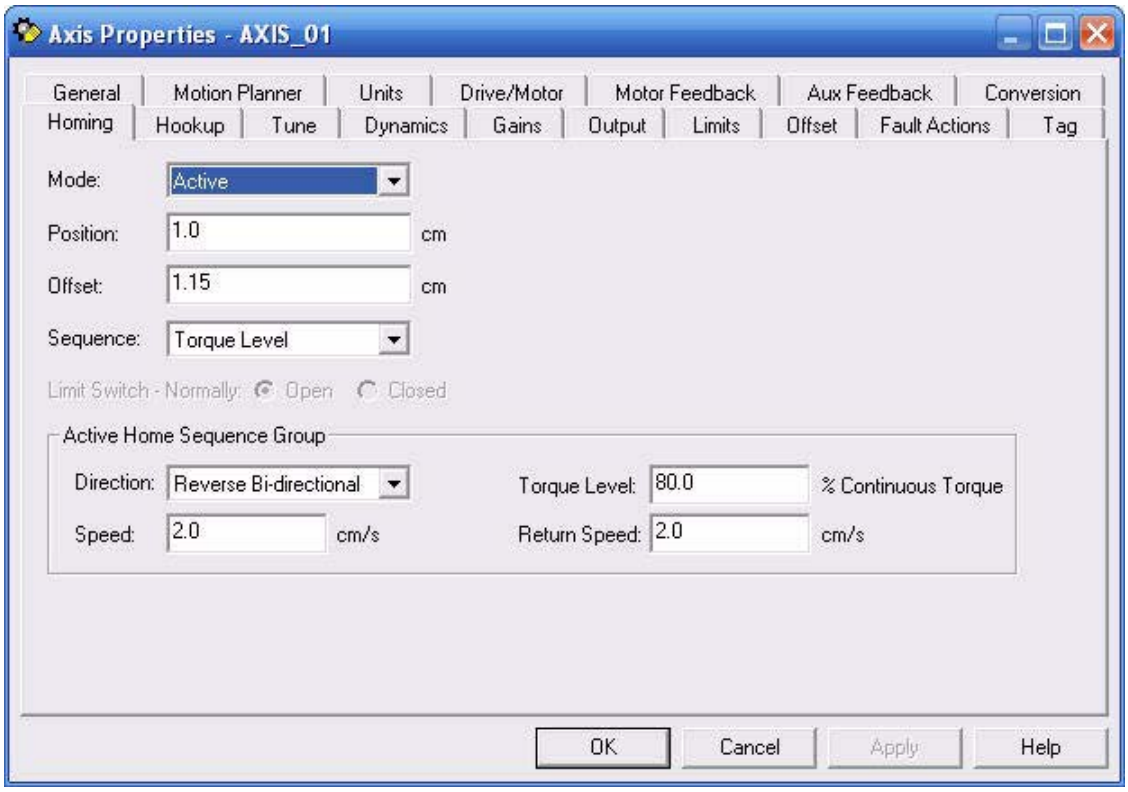


Figure 22 - Axis Properties - Limits Tab

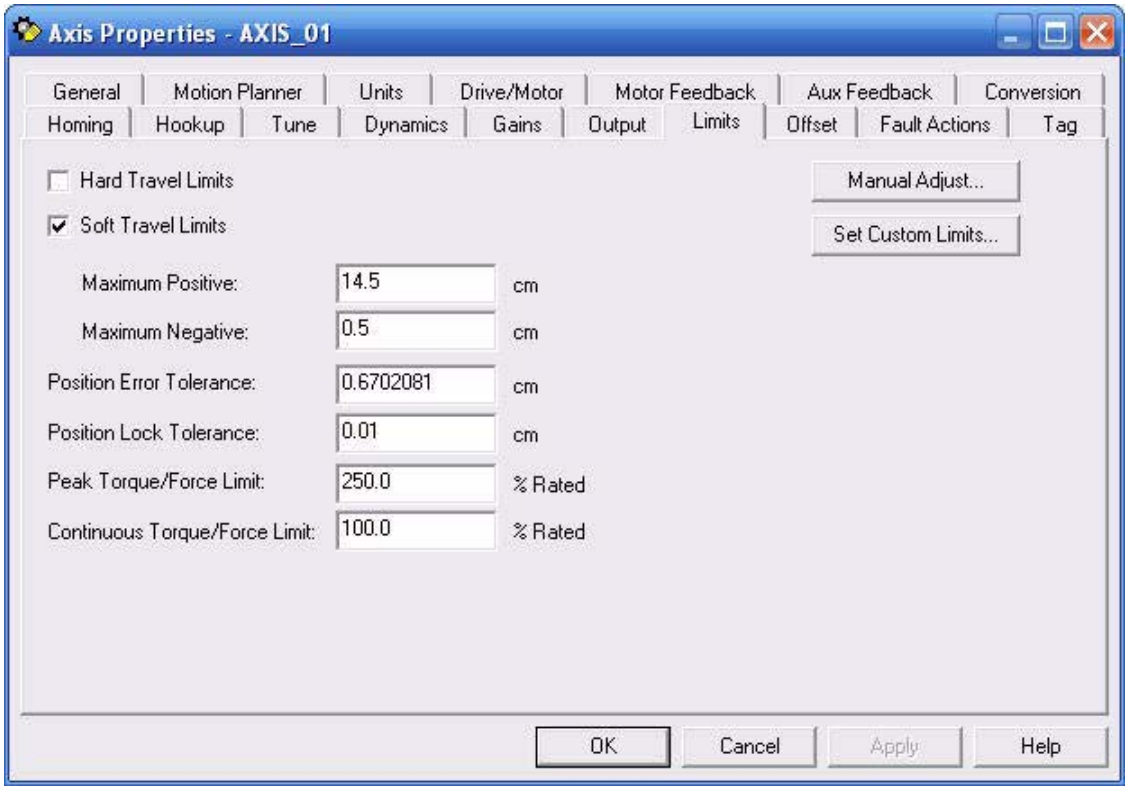


Table 54 - Ladder Code Example

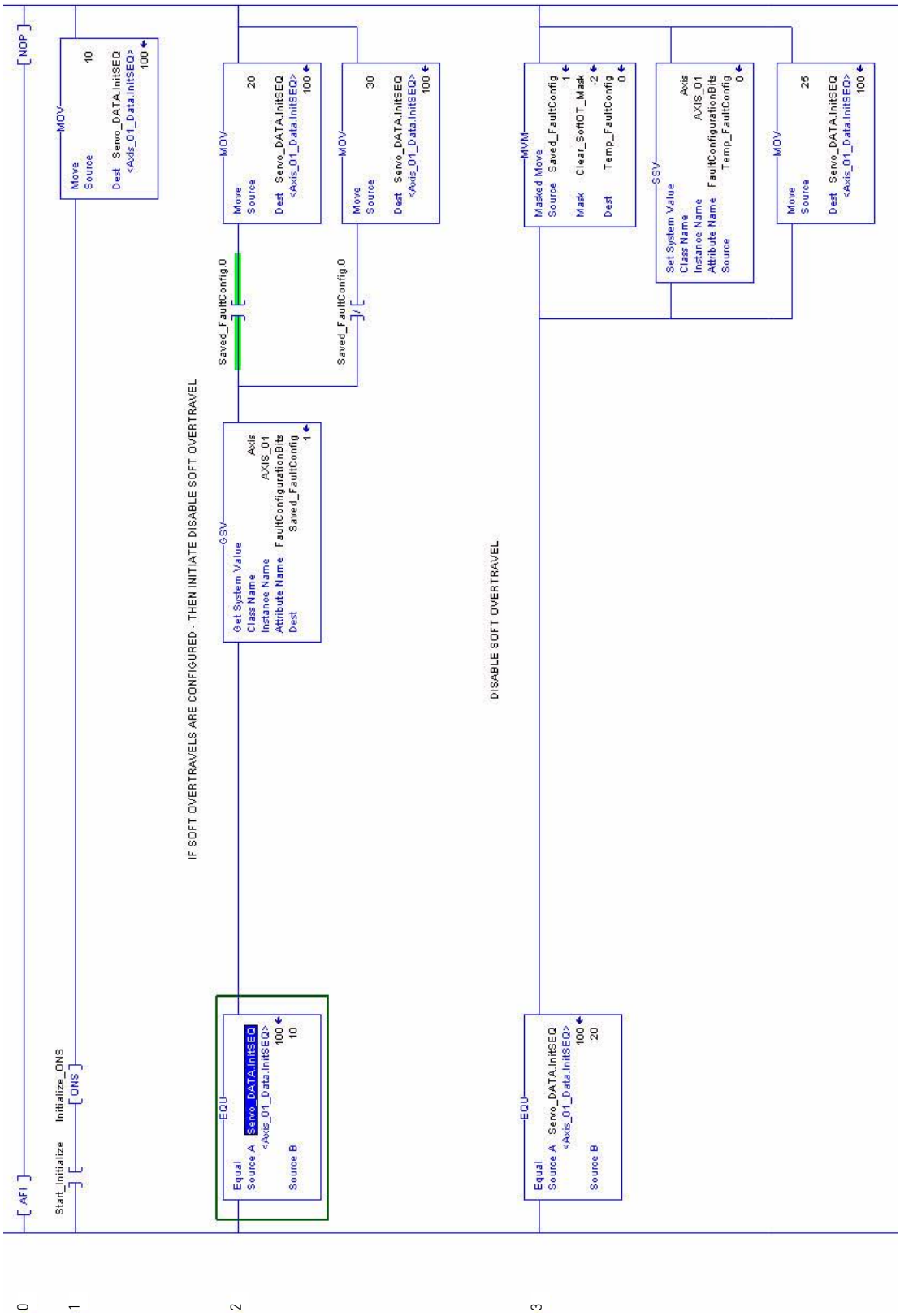


Table 55 - Ladder Code Example, continued

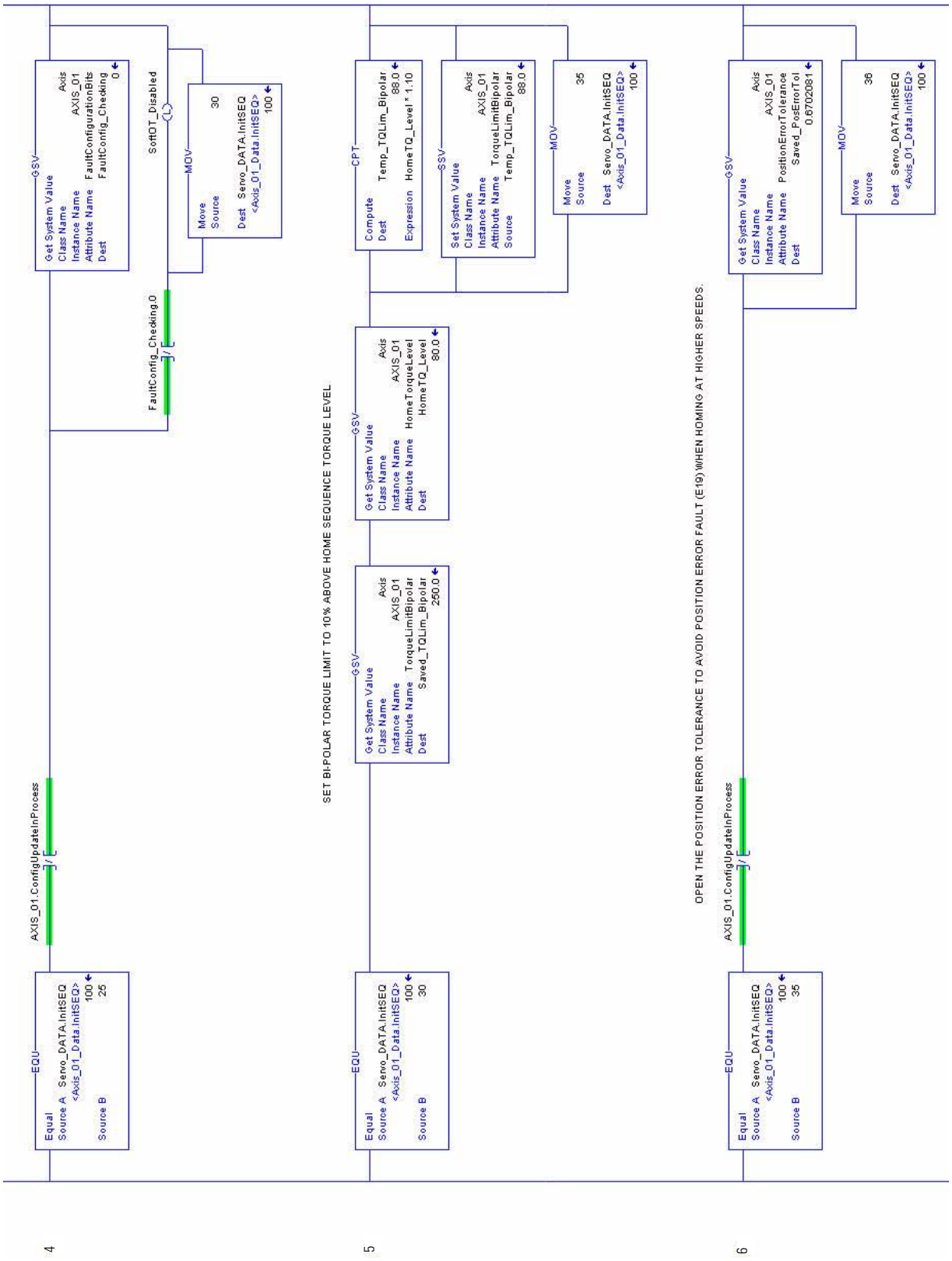


Table 56 - Ladder Code Example, continued

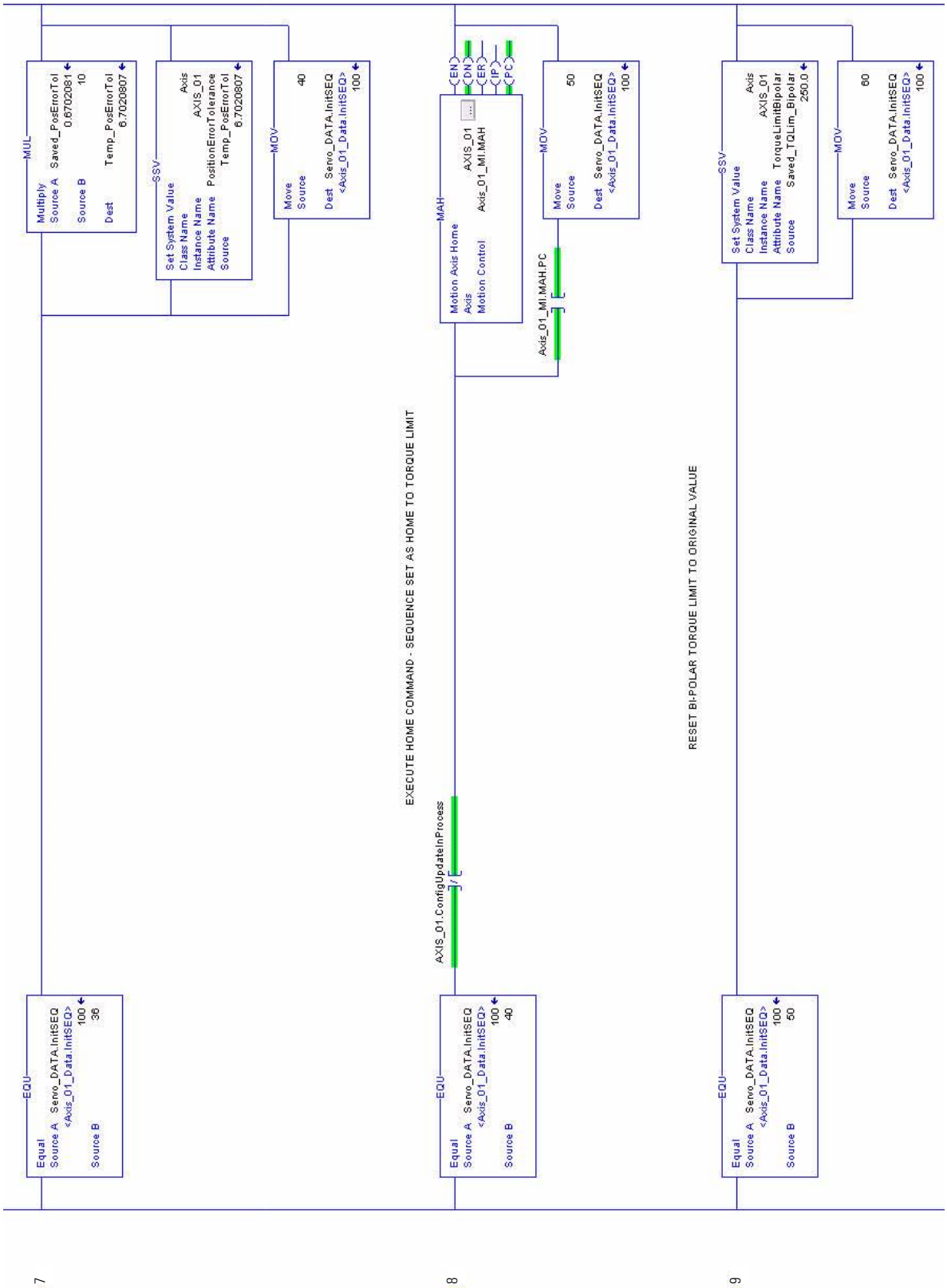


Table 57 - Ladder Code Example, continued

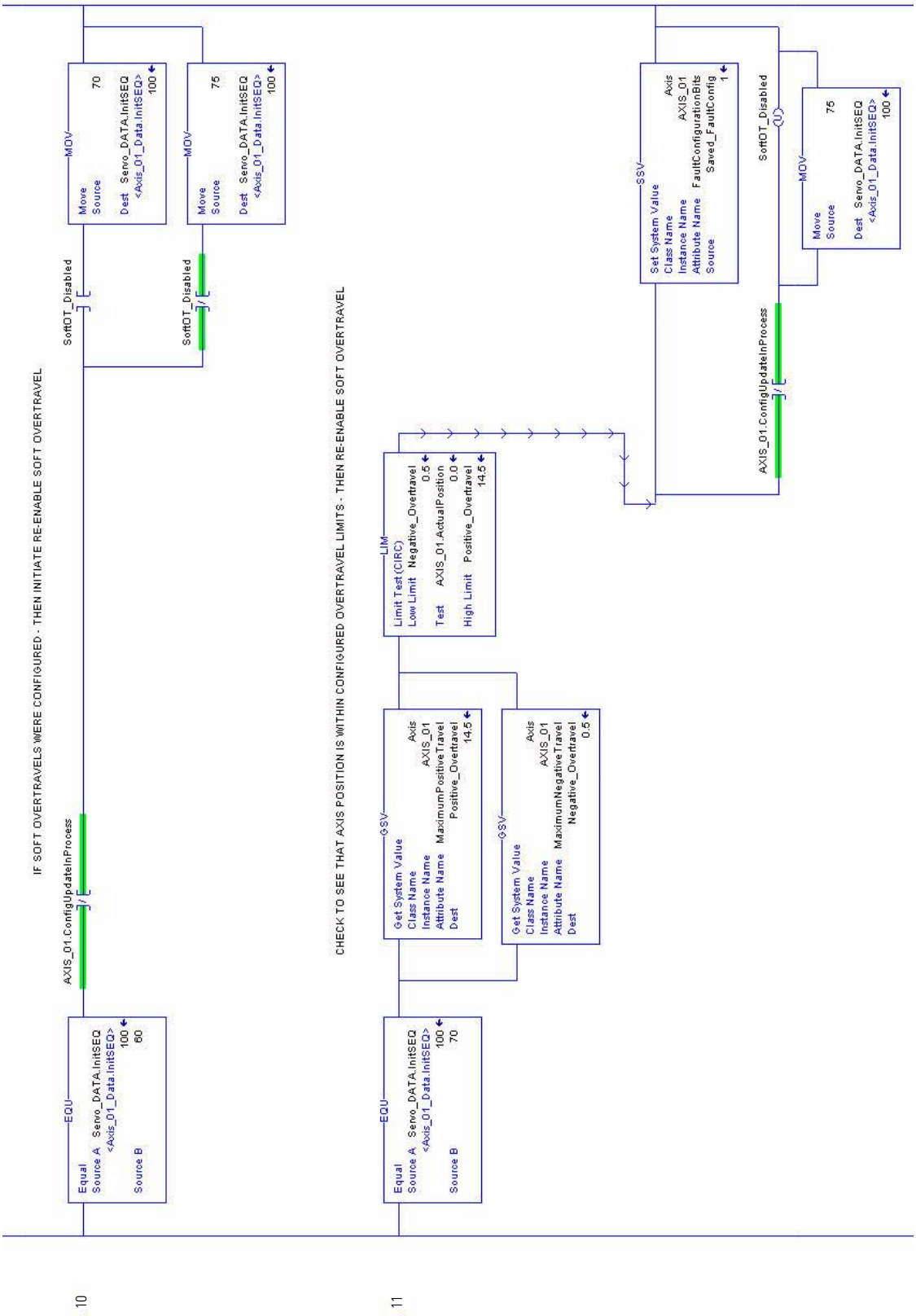
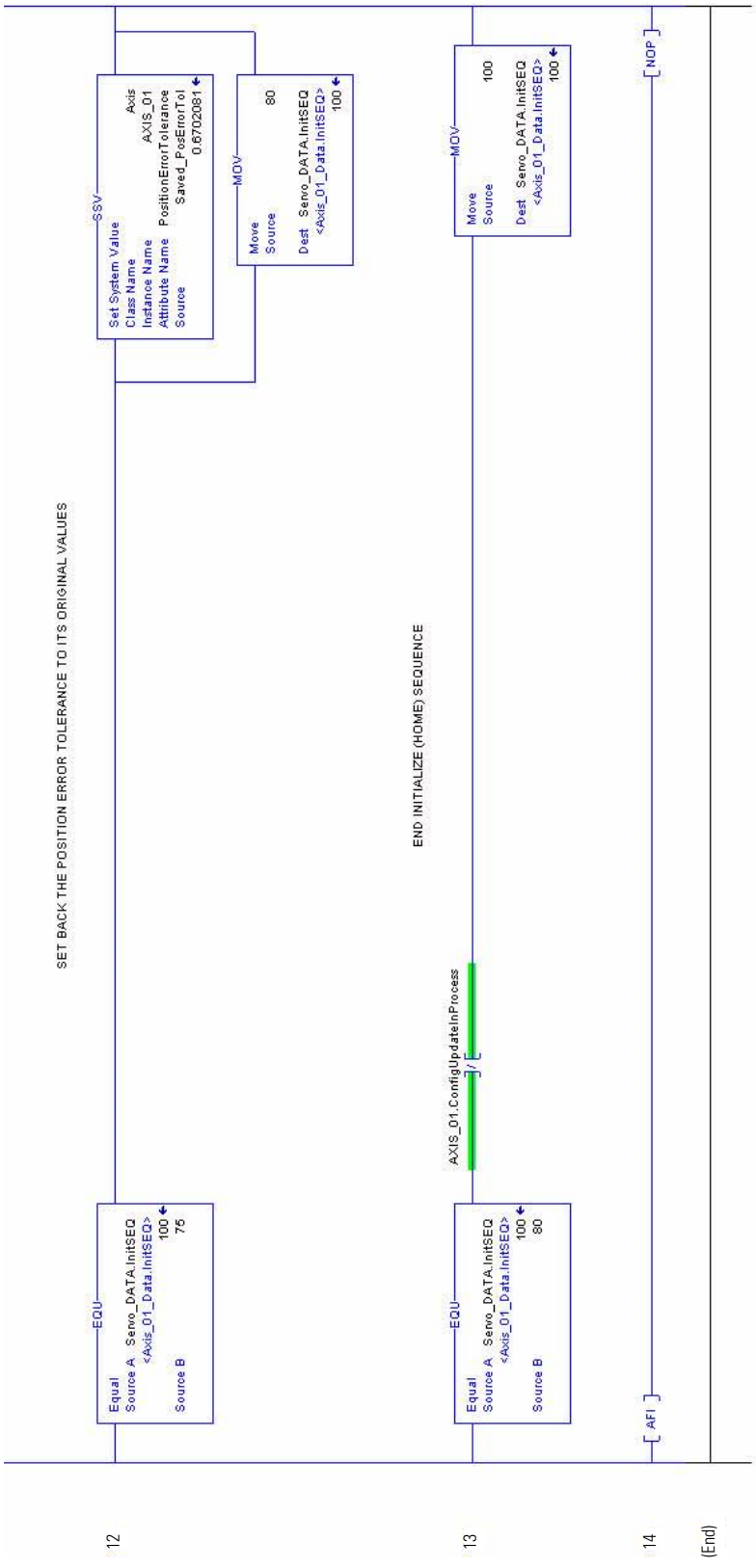


Table 58 - Ladder Code Example, continued



Potential for Position Error

When executing a torque limit homing procedure there is potential for a position error. As mentioned earlier, for the home to torque limit to complete, the output torque to the motor must reach or exceed the specified torque level for a set time of 500 ms. During this time the axis is against the mechanical hard-stop, and following error is increasing in the position loop. If the Position Error Tolerance value is exceeded before completion of the homing instruction, a Position Error (E19) results.

There are two methods to limit the occurrence of an E19.

- Set the Position Error Tolerance value on the Limits tab of the Axis Properties to 10 mm.
- Modify the Position Error Tolerance value to 10 mm using a SSV instruction code. You can use code similar to the code on page 122 which is used to change the Bipolar Torque Limit.

TIP The second method is preferred because it temporarily sets Position Error Tolerance to a value appropriate for homing to a mechanical hard-stop and then resets it to the original value set in the Axis Properties dialog box.

Rung 6 of the ladder code opens the Position Error window. This lets the Homing complete without causing a Position Error. The original value is reset after Homing completes.

Mounting Bolts and Torque Values

Introduction

This appendix provides typical torque values for standard and metric bolts.

Topic	Page
Recommended Seating Torque for Metric Bolts	127
Recommended Seating Torque for Mild Steel Rb 87 or Cast Iron Rb 83	128
Recommended Seating Torque for Brass Rb 72	129
Recommended Seating Torque for Aluminum Rb 72 (2024-T4)	130

Table 59 - Recommended Seating Torque for Metric Bolts

Bolt Size (Metric) (1)	Pitch	Plain	Cadmium Plated	Zinc
		Nm (lb•in)	Nm (lb•in)	Nm (lb•in)
M1.6 (2)	0.35	0.29 (2.6)	0.22 (1.95)	0.41(3.64)
M2 (2)	0.40	0.60 (5.3)	0.45 (3.98)	0.84 (7.42)
M2.5 (2)	0.45	1.24 (11)	0.93 (8.25)	1.74 (15.4)
M3	0.5	2.15 (19)	1.61 (14.25)	3.00 (26.6)
M4	0.7	4.6 (41)	3.47 (30.75)	6.48 (57.4)
M5	0.8	9.6 (85)	7.20 (63.75)	13.4 (119)
M6	1.0	15.8 (140)	11.9 (105)	22.1 (196)
M8	1.25	39.5 (350)	29.7 (262.5)	55.4 (490)
M10	1.5	76.8 (680)	57.6 (510)	115.2 (1020)

(1) Mounting hardware is ISO 898/1 socket head cap bolt that meets or exceeds ANSI B113M, ISO 261, ISO 262 (coarse series only).
(2) Microsize bolt.

Table 60 - Recommended Seating Torque for Mild Steel Rb 87 or Cast Iron Rb 83

	UNC		UNF	
	Plain	**Cadmium Plated**	**Plain**	**Cadmium Plated**
Bolt Size (1), (2)	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)
#0	–	–	0.24 (2.1) (3)	0.18 (1.6) (3)
#1	0.44 (3.89) (3)	0.53 (4.7) (3)	0.46 (4.1) (3)	0.34 (3.0) (3)
#2	0.71 (6.3) (3)	0.53 (4.7) (3)	0.76 (6.8) (3)	0.58 (5.1) (3)
#3	1.08 (9.6) (3)	0.81 (7.2) (3)	1.16 (10.3) (3)	0.87 (7.7) (3)
#4	1.52 (13.5) (3)	1.13 (10) (3)	1.67 (14.8) (3)	1.2 (11) (3)
#5	2.3 (20) (3)	1.7 (15) (3)	2.37 (21) (3)	1.8 (16) (3)
#6	2.8 (25) (3)	2.1 (19) (3)	3.2 (28) (3)	2.4 (21) (3)
#8	5.2 (46) (3)	3.8 (34) (3)	5.4 (48) (3)	4.1 (36) (3)
#10	7.6 (67) (3)	5.6 (50) (3)	8.6 (76) (3)	6.4 (57) (3)
1/4	17.8 (158) (3)	13.4 (119) (3)	20.3 (180) (3)	15.4 (136) (3)
5/16	36.8 (326) (3)	27.7 (245) (3)	40.7 (360) (3)	30.5 (270) (3)
3/8	65.5 (580) (3)	49.1 (435)	71.7 (635)	53.7 (476)
7/16	105 (930) (3)	78.9 (698) (3)	117.5 (1,040) (3)	88.1 (780) (3)
1/2	160 (1420) (3)	172.8 (1530) (3)	254.2 (2250)	190.9 (1690)) (3)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.
(2) Torque is based on 80,000 psi bearing stress under the head of the bolt.
(3) Denotes torque based on 100,000 psi tensile stress, with threads up to one inch in diameter.

Table 61 - Recommended Seating Torque for Brass Rb 72

	UNC		UNF	
	Plain	**Cadmium Plated**	**Plain**	**Cadmium Plated**
Bolt Size [1], [2]	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)
#0	–	–	0.24 (2.1) [3]	0.18 (1.6) [3]
#1	0.43(3.8) [3]	0.33 (2.9) [3]	0.46 (4.1)	0.34 (3.0) [3]
#2	0.71 (6.3) [3]	0.53 (4.7) [3]	0.77 (6.8) [3]	0.58 (5.1) [3]
#3	1.08 (9.6) [3]	0.81 (7.2) [3]	1.16 (10.3) [3]	0.87 (7.7) [3]
#4	1.52 (13.5) [3]	1.1 (10) [3]	1.67 (14.8) [3]	1.24 (11) [3]
#5	2.2 (20) [3]	1.7 (15) [3]	2.4 (21) [3]	1.8 (16) [3]
#6	2.8 (25) [3]	2.1 (19) [3]	3.2 (28) [3]	2.4 (21) [3]
#8	5.2 (46) [3]	3.8 (34)	5.4 (48) [3]	4.1 (36) [3]
#10	7.6 (67) [3]	5.6 (50) [3]	8.6 (76) [3]	6.4 (57) [3]
1/4	15.3 (136)	11.5 (102)	15.4 (136)	11.5 (102)
5/16	25.8 (228)	19.3 (171)	25.8 (228)	19.3 (171)
3/8	53.7 (476)	40.3 (357)	53.7 (476)	40.3 (357)
7/16	76.8 (680)	57.6 (510)	76.8 (680)	57.6 (510)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.
(2) Torque is based on 60,000 psi bearing stress under the head of the bolt.
(3) Denotes torques based on 100,000 psi tensile stress with threads up to one inch in diameter.

Table 62 - Recommended Seating Torque for Aluminum Rb 72 (2024-T_4)

	UNC		UNF	
	Plain	**Cadmium Plated**	**Plain**	**Cadmium Plated**
Bolt Size [1], [2]	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)	Nm (lb•in)
#0	-	-	0.24 (2.1) [3]	0.18 (1.6) [3]
#1	0.44 (3.8) [3]	0.33 (2.9) [3]	0.46 (4.1) [3]	0.34 3.0v
#2	0.71 (6.3) [3]	0.53 (4.7) [3]	0.77 (6.8) [3]	0.58 (5.1) [3]
#3	1.08 (9.6) [3]	0.81 (7.2) [3]	1.16 (10.3) [3]	0.87 (7.7) [3]
#4	1.52 (13.5) [3]	1.1 (10) [3]	1.67 (14.8) [3]	1.24 (11) [3]
#5	2.3 (20) [3]	1.7 (15) [3]	2.37 (21) [3]	1.8 (16) [3]
#6	2.8 (25) [3]	2.1 (19) [3]	3.2 (28) [3]	2.37 (21) [3]
#8	5.2 (46) [3]	3.8 (34) [3]	3.2 (48) [3]	4.1 (36) [3]
#10	7.6 (67) [3]	5.6 (50) [3]	8. 6 (76) [3]	6.4 (57) [3]
1/4	12.8 (113)	9.6 (85)	12.8 (113)	9.6 (85)
5/16	21.5 (190)	16.1 (143)	21.5 (190)	16.1 (143)
3/8	44.8 (397)	33.6 (298)	44.8 (397)	33.7 (298)
7/16	64.4 (570)	48.0 (425)	64.4 (570)	48.0 (425)
1/2	159.3 (1410)	119.8 (1060)	159.3 (1410)	119.8 (1060)

(1) Mounting hardware is 1960-series socket head cap bolt that meets or exceeds ANSI B18.3.
(2) Torque is based on 50,000 psi bearing stress under the head of the bolt.
(3) Denotes torques based on 100,000 psi tensile stress with threads up to one inch in diameter.

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